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STUDIES OF LIPASE ACTION. I. LIPASE ACTION IN NORMAL MILK

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It is now generally recognized that cows milk contains an enzyme capable of hydrolyzing fat. This enzyme is responsible for the rapid development of rancidity in homogenized raw milk, and the bitter flavor often associated with milk secreted by cows in a late stage of lactation. Milk from cows in an advanced stage of lactation may be abnormal in several respects. This paper deals with lipase action in normal milk which has not been homogenized.

Several changes occur in milk as a result of lipase action. The more obvious are the changes in odor, flavor, and titratable acidity. Most investigations of lipase action in milk have been based upon measurements of the increase in titratable acidity of the milk, but the method has several disadvantages. The end point of the titration is not very distinct, lactic acid fermentation must be prevented, and only a part of the fatty acids liberated by the hydrolysis of fat are water soluble.*

As contrasted with this method, the direct determination of free acid in the fat phase seemed to offer definite advantages. It would not be necessary to correct for acidity due to the protein and salts of milk. Greater quantities of acid might be found in the fat than in the water phase, and the formation of moderate amounts of lactic acid would not interfere. This method was tried and found very satisfactory. With its help, we have been able to detect and measure changes which have been overlooked in the past. After the work was well under way, it was discovered that Paraschtschuck (5) in 1909 and Gould and Trout (4) in 1936 had recommended similar methods for the study of lipase in milk.

THE METHOD

The actual test was performed by churning a half-pint sample of milk,[1]

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We are indebted to the Joseph Willmann Dairy Research Fund for a grant in aid of this investigation.

* Davis (1) has reported that oleic acid is the one set free in greatest amount.

[1] A part of the skimmilk was usually removed first by means of a siphon.

which had been heated previously to destroy the enzyme, transferring the butter to a centrifuge tube, and centrifuging in a heated centrifuge to secure a clear layer of oil. After weighing five grams of the oil into a small flask, 20 ml. of neutral alcohol and 5 drops of 1 per cent phenolphthalein solution were added. The mixture was heated to boiling and titrated with N/20 alkali (NaOH in 50 per cent alcohol). All results in this paper are reported as ml. of N/20 alkali neutralized by 5 grams of fat. This is numerically equivalent to the acid value of Trout, and to the acid degree as recognized by the Association of Official Agricultural Chemists.

THE EXPERIMENTS

As a test of the reproducibility of the titration, one of the writers weighed out a series of samples varying in weight from 0.5 to 6 grams. These samples were titrated by the other without knowledge of the weight of the samples. A linear relation was found between the weight of the sample and the titration. The titration error was approximately $\pm$ .03 ml.

After this preliminary test of the method, an experiment was planned to determine normal values for the fat acidity of commercial market milk. Samples of pasteurized milk were obtained from sixty-eight dairy plants distributed over the state of New York. These samples were packed in ice and sent by express to the laboratory, where the acid degree was determined. The results of these analyses are given in Figure 1. The values range from 0.30 to 1.12, but more than half of the values fall between 0.3 and 0.5.

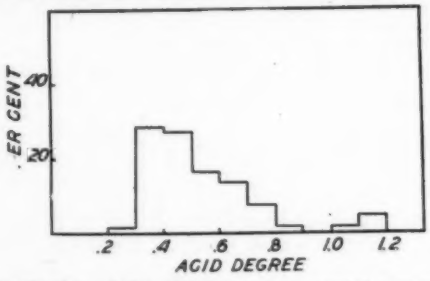

FIG. 1. The distribution of fat acidities in commercial pasteurized milk samples from 68 dairies.

The data of Figure 1 show that the fat in commercial pasteurized milk contains appreciable quantities of free acid, but it is not evidence of enzyme action since the acidity of the fat at the time of milking is unknown. In order to learn the normal values for fresh milk fat, tests were made on the milk of 76 individual cows in the University herd. This herd was made up of Jersey, Guernsey, Brown Swiss, Ayrshire and Holstein cows. The samples represented all stages of lactation. They were pasteurized in glass

bottles, and each sample was heated within 5 minutes after the milking was completed. Figure 2 shows the distribution of the values which were obtained. A comparison of these data with that in Figure 1 indicates that lipase must be active in market milk between the time of milking and the time of pasteurization.

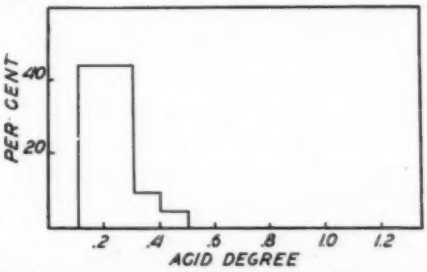

FIG. 2. The distribution of fat acidities in fresh milk samples from 76 individual cows.

These results suggested that when night and morning milk are both delivered to the pasteurizing plant in the morning, it should be possible to distinguish between them on the basis of fat acidity. The night milk should yield higher values because it is older. To test this hypothesis, eight pairs of samples were taken at a local dairy. Each pair consisted of one sample representing all of the night milk and one representing all of the morning milk delivered by one patron. The samples were packed in ice and taken to the laboratory where they were pasteurized at once. Figure 3 shows the

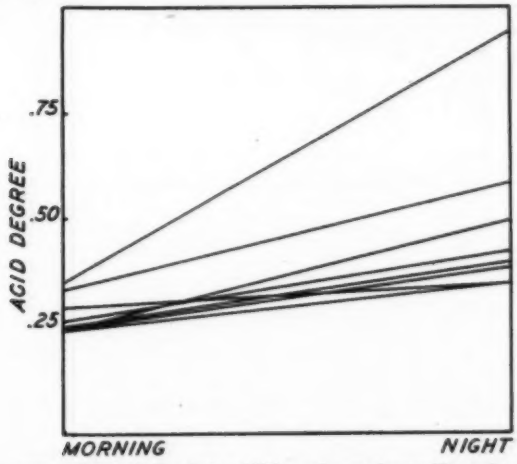

FIG. 3. A comparison of the fat acidities of morning milk and night milk when delivered to a dairy plant in the morning

relation between the values for the night and morning milk delivered by each patron. In every case, the older milk gave higher values. The great variation in the magnitude of the increase due to aging, indicates that some samples may contain more of the enzyme than others.

These experiments are not conclusive evidence for lipase action in normal milk since the initial value for the evening milk was not determined. In order to secure more conclusive evidence, a series of ten samples were taken from the afternoon milking of the University herd. As soon as the milkers filled a forty-quart can, the can was tagged, and a sample was pasteurized at once. The cans were held in a refrigerated tank of cold water until delivery to the pasteurizing plant the next morning. At that time, another set of samples was taken for comparison with the first set. Figure 4 shows the increase in acidity of the fat between the time of milking and of delivery at the plant. These data are in good agreement with those given in Figure 3 and are considered conclusive evidence of lipase action in normal milk under commercial conditions of handling.

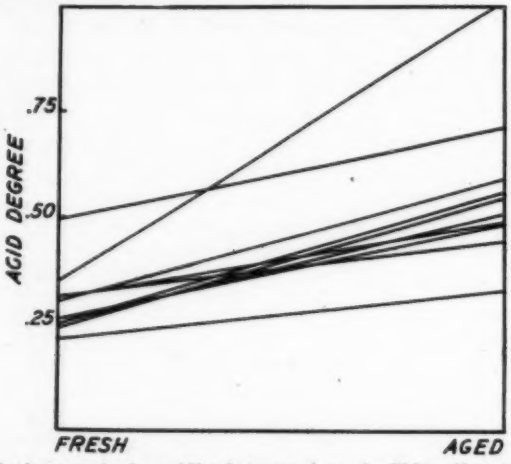

FIG. 4. The increase in fat acidity between time of milking (3 p. m.) and time of delivery at the pasteurizing plant (7 a. m.). Ten cans of milk cooled in cold water at C. U. dairy barn.

The data of Figures 3 and 4 indicate considerable variation between different lots of mixed milk. It seemed likely that even greater variation might be found if a study were made of milk from individual cows. For this purpose, individual samples were taken in the afternoon. Half of each sample was tested at once; the remainder was held in ice water until the next morning. Figure 5 shows the relation between the original acidity and the acidity of the aged sample. The results do indicate a greater vari-

ation in enzyme content than was found for mixed milk, though there is surprisingly little variation in the initial values.

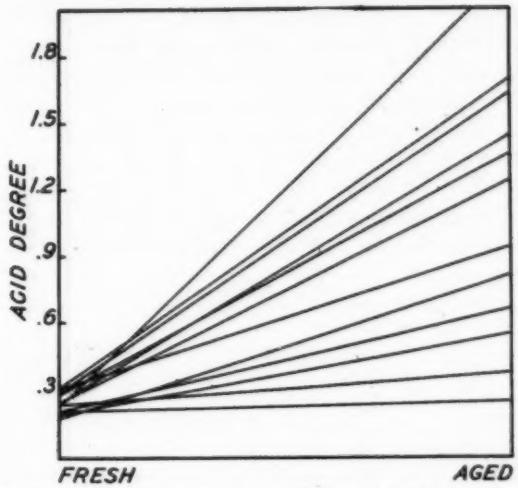

FIG. 5. The increase in fat acidity of milk from individual cows. Milk held 24 hours at 0° C.

These experiments had shown that a definite increase of free acid occurred during a period of 16 hours. In order to learn more about the rate of lipolysis, three series of samples were prepared representing three lots of mixed milk. These were stored in ice water and samples were taken

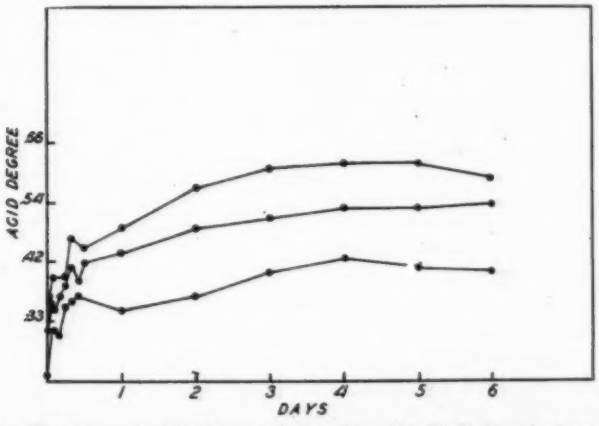

FIG. 6. The change in acid degree of three lots of milk during six days storage in ice water. *The ordinate .33 should read .30.*

from each series after various intervals of time for test. Figure 6 shows that lipolysis was most rapid during the first few hours but that it continued at a slower rate throughout the six days of the experiment.

In order to learn if the rate of cooling were a factor influencing lipase action, three lots of mixed fresh milk were obtained, and each was divided into four parts. One portion was pasteurized at once, without cooling, to serve as a control. A second portion was cooled slowly by placing a half-pint bottle in air at 0° C. A third portion was cooled more rapidly by placing the bottle in ice water. A fourth portion was cooled by means of a small tubular cooler which reduced the temperature from 38° C. to 3.5° C. in less than thirty seconds. These samples were all stored at 0° for 24 hours.

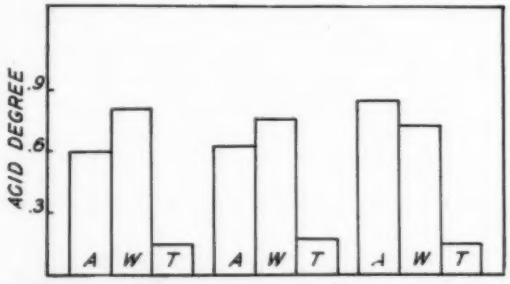

FIG. 7. The effect of rate of cooling upon lipolysis during 24 hours storage at 0° C. three lots of milk, each cooled in air, in water, and in a tubular cooler. The initial acidities of the milk have been subtracted.

The results of these experiments are shown in Figure 7. Apparently it was of little consequence whether the milk was cooled in air or in water, but very rapid cooling reduced subsequent lipolysis to a marked degree. In connection with this experiment, it should be remembered that, even in air, a half-pint of milk is cooled quite rapidly as compared with the cooling of milk in 40-quart cans. These results suggest that the use of a surface cooler for fresh milk might result in an improvement in quality. This might be of practical value in the production of certified or other raw milk.

It is known that lipase action is accelerated by agitation of the milk (3). In order to determine if the rate of cooling affected the sensitivity of the milk to agitation, portions of the same milks cooled in the preceding experiment were churned raw on the following day. These samples yielded higher values than the preceding set due, in part, to the longer storage period, and in part to the effect of agitation. It is believed that the greater part of the increase was due to agitation since earlier work had indicated that lipolysis during the second day of storage at 0° C. is less than that dur-

ing the first day. Figure 8 shows the acid degrees which were found. It is apparent that very rapid cooling did not reduce the sensitivity of the milk to agitation.

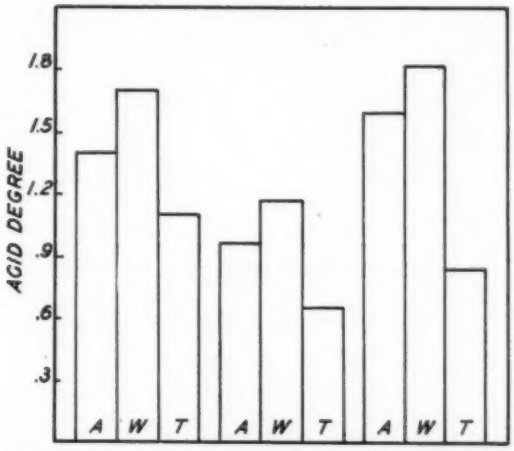

FIG. 8. The effect of rate of cooling upon the acid degree of milk fat churned raw after 48 hours storage at 0° C. Three lots of milk, each cooled in air, in water, and in a tubular cooler. The initial acidities of the milk have been substracted.

Davies (1) has reported that copper reduces lipolysis in milk but he used relatively large amounts of copper (2 and 10 p.p.m.). The effect of smaller amounts of copper upon lipolysis in raw milk was studied by adding copper sulphate to a series of samples. Lipase action at 0° C. was reduced about 20 per cent by 0.2 and 0.4 p.p.m. of copper. Smaller amounts had less effect; larger amounts were not used in this experiment.

Several investigators have used formalin to inhibit bacterial action during the study of lipase action. In general it has been believed that formalin might retard the action of lipase but did not destroy it. Paraschtschuck (5) considered his experiments to be proof that formalin had no action on the lipase of milk. A comparison of his experiment with the following one will disclose the cause of his error.

In order to determine what effect formalin might have upon lipase, a sample of 20 per cent cream was prepared by separating milk at 38° C. within a few minutes after milking. Five samples of 160 ml. each were placed in bottles and formalin was added in increasing amounts of 0, 1, 3, 9, and 27 drops. After careful mixing, the samples were stored in ice water for one week. This experiment was repeated on two subsequent occasions.

Figure 9 shows the increase in acidity which occurred during the storage period. These data show clearly that one drop of formalin in 160 ml. of

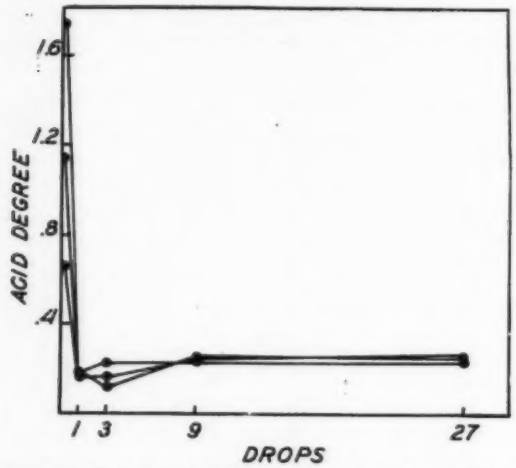

FIG. 9. The effect of 0, 1, 3, 9 and 27 drops of formalin in 160 ml. of milk upon lipolysis during one week at 0° C. Three different lots of milk. The chart shows increase in acidity. The initial values have been subtracted.

20 per cent cream may reduce lipase action to a small fraction of its original value. It also shows that even 27 drops of formalin does not eliminate all of the lipolysis, nor is 27 drops more effective than a single drop. These results are considered as additional evidence for the existence of two lipases in milk (2), one being resistant to formalin, the other being destroyed by it. The criticism that the high value without formaldehyde is due to micro-organisms is disproved by the fact that the greater part of the increase in acidity occurs during the first two days of storage.

SUMMARY

By a direct determination of the free acids in the fat phase, it has been shown that lipolysis occurs in practically all samples of raw milk, and that there is an appreciable increase in free fatty acids between the time of milking and the time of delivery to a pasteurizing plant.

There is only a slight variation in the acidity of the fat in the milk of different cows when it is drawn from the udder, but after a few hours there may be wide variations in the acidity.

The rate of lipase action is influenced by the rate of cooling of the milk, being retarded by sufficiently rapid cooling.

Milk contains at least two lipases. One is inhibited completely by very small amounts of formalin. The other is apparently not sensitive to moderate amounts of formaldehyde.

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STUDIES OF LIPASE ACTION. II. THE ACTIVATION OF MILK LIPASE BY TEMPERATURE CHANGES

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In order to account for certain irregularities which were observed in our studies of lipase action in natural raw milk, it seemed necessary to postulate that lipase could be activated by the momentary warming of cold milk. If this were true, it would be of considerable practical importance because raw milk is often allowed to warm slightly without any thought of its possible effect upon lipolysis.

In the following paragraphs, evidence is presented to show that lipolysis in natural raw milk may be greatly stimulated by temperature fluctuations. This phenomenon was studied in some detail, and data are presented to show the importance of the several variables which are involved.[1]

EXPERIMENT 1

The stimulating effect of preheating upon the subsequent rate of lipolysis in milk stored at a low temperature

A 40-quart can of mixed milk from the afternoon milking was cooled over night in water at 3–4° C. After 16.5 hours, the can of milk was warmed by placing it in a tank of water which was heated slowly. Samples were taken from this can as the temperature reached values of 15°, 20°, 25°, 30°, 35°, 40°, 45°, and 50° C. These samples were cooled in water at once, and then stored at 0–5° C. for a period of 48 hours. At the end of that time, a part of each sample was churned raw, and the remainder was churned after pasteurizing to destroy lipase. The acid degrees of these fats were then compared with that of the fat in the fresh milk, with that of milk held the same length of time, but not warmed, and with the value at the end of the heating period before the low temperature storage. This experiment was repeated a week later with another lot of milk.

The data of one experiment is presented in Figure 1. The second gave almost identical results. It is apparent that the warming of cold raw milk greatly accelerates the subsequent lipolysis while the milk is held cold, and that the activation is a maximum when the milk is warmed to approximately 30° C.

EXPERIMENT 2

The influence of the duration of heating upon the subsequent rate of lipolysis

In the experiment just described, the samples were cooled immediately

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We are indebted to the Joseph Willmann Dairy Research Fund for a grant in aid of this investigation.

[1] The methods used in this investigation were those described in the preceding paper.

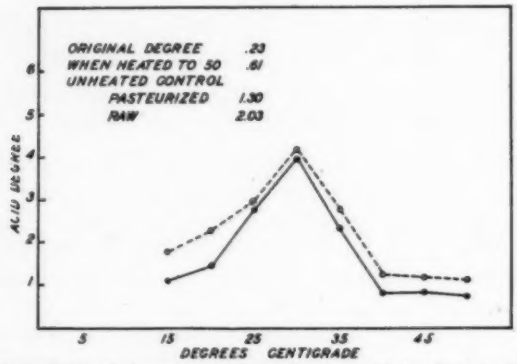

FIG. 1. The relation between the temperature to which milk is preheated, and the acid degree after 48 hours storage at 0–5° C. The values of samples churned raw are indicated by the broken line.

after the desired temperature had been reached. Since it seemed possible that the changes responsible for the activation might not occur instantly, it was thought desirable to hold part of each sample at the specified temperature for a period of time before cooling and storing. Accordingly portions were held for 5, 10, 20, and 30 minutes at each temperature. They were then cooled and held for 48 hours before churning, as described in the preceding experiment.

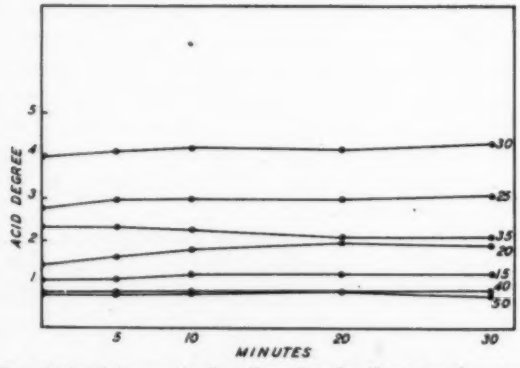

FIG. 2. The relation between the duration of preheating at various temperatures, and the acid degrees after 48 hours storage at 0°–5° C. The 45° line is not shown because of lack of space between the 40° and 50° lines.

The data for the samples of milk pasteurized immediately before churning are shown in Figure 2. The data for the raw samples are omitted to avoid confusion. Both sets of data indicate that the activation, at a given temperature, occurs rapidly and that there is little increase in activation due

to holding. In this experiment, the milk was heated approximately 0.37° C. per minute. If it had been heated more rapidly, different results might have been obtained.

EXPERIMENT 3

A comparison of lipolysis in normal and in activated milk

In order to study the comparative rates of lipolysis in normal and in activated milk, a series of identical samples of fresh cold milk was prepared, half of these samples were activated by warming to 30° C. and all were stored in ice water. Bottles were taken at one hour intervals from each series for the determination of fat acidity. This experiment was performed using mixed milk known to show high lipolytic activity and also with mixed milk known to be low in lipase.

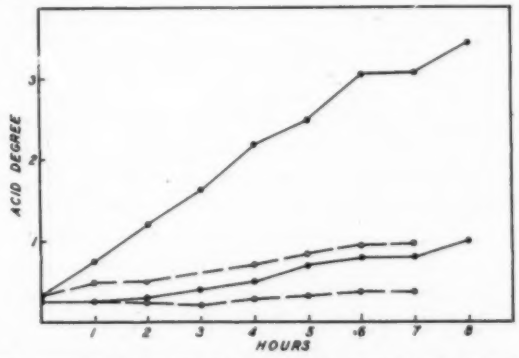

FIG. 3. The comparative rates of lipolysis in normal and activated milk. The activated samples are represented by solid lines. These two lots of milk represent the two extremes which are likely to be found in mixed milk.

The data are presented in Figure 3. It is apparent that the milk fat, activated by warming is attacked very much more rapidly by lipase than that which was not activated. The amount of activation which can be produced by warming is related, however, to the original lipolytic activity of the milk.

These experiments confirmed the original hypothesis that the rate of lipolysis is greatly affected by the previous heat treatment of the milk. In order to learn more about the phenomena involved, a number of additional experiments were performed.

EXPERIMENT 4

The influence of the temperature of pre-cooling upon the degree of activation produced by warming

A can of milk was obtained at milking time and cooled by placing it in ice water. Samples were taken as the temperature reached values of 25°,

20°, 15°, 10°, 5°, and 0° C. These samples were immediately warmed to 30° C. and then placed in a cooler at 0–5° C. After 48 hours storage, a part of each sample was pasteurized and churned. The remainder was churned without pasteurization. This experiment was performed at two different times with different lots of milk. The data of one experiment is shown in Figure 4. The second experiment yielded almost identical curves. It is ap-

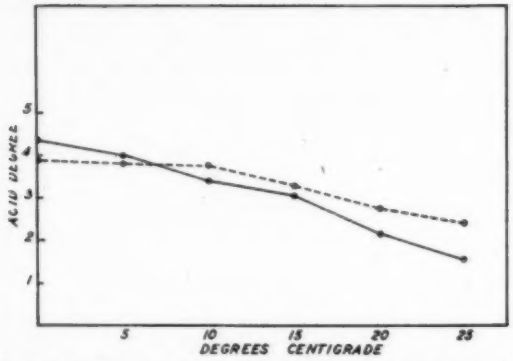

FIG. 4. The relation between the temperature to which milk was pre-cooled, and the acid degree 48 hours after activation. The dotted line represents samples which were churned raw.

parent that the degree of activation possible by warming increases as the pre-cooling is carried to lower temperatures.

It is interesting to note that the milks most highly activated do not respond to shaking during the churning process to so great a degree as those less highly activated. The samples pre-cooled to quite low temperatures actually show less fatty acids when churned raw than when churned after pasteurization. This reversal was noted in a number of cases where the acidity of the fat was quite high. Perhaps this can be explained by assuming that during the agitation, there is a distribution of water soluble acids between the water phase and the surface layer of the fat globule. In the case of pasteurized milk, there is a lower concentration of acid in the surface of the globule because, when the fat was melted, the acid diffused into the center of the fat droplet. Consequently, less acid would be lost to the water phase when that was in equilibrium with the heated fat than when it was in equilibrium with the unheated fat. It is also necessary to assume that lipolysis is retarded by the higher concentration of acids, but this seems fairly well established by a number of experiments.

EXPERIMENT 5

The influence of the duration of pre-cooling upon the rate of lipolysis after activation

In the experiment just described, the samples of milk were rewarmed

immediately after they had been cooled to the desired temperature. Since the hardening of fat is a slow process, it seemed desirable to hold portions of the milk at the various temperatures for a period of time before warming in order to determine if prolonged cooling would make possible a greater activation by subsequent warming and cooling. For this purpose, samples were taken from a can of milk during cooling as the temperature reached 25°, 20°, 15°, 10°, 5°, and 0° C. Each sample was stored at its own temperature. A part was activated at once, and other portions were activated after 5, 15, and 45 minutes. The acidity of the fat was then determined after 48 hours storage at 0–5° C.

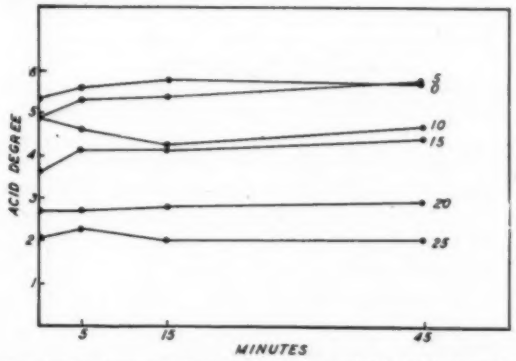

FIG. 5. The relation between the length of time milk is held at various low temperatures before activation, and the acid degree after 48 hours storage of the activated milk at 0–5° C.

The data are shown in Figure 5. Experimental errors are apparent in some of the values, but it seems probable that in the case of normal slow cooling, the temperature to which the milk is cooled is of greater importance than the duration of storage at the low temperature, at least during storage periods of an hour or less.

EXPERIMENT 6

The effect of storage temperature upon the rate of lipolysis in milk activated by warming

A sample of mixed milk was obtained at the barn and cooled to 0° C. in a mixture of ice and salt. It was then warmed to 30° C. in a tank of water at 35° C. and re-cooled. Two samples were taken during the second cooling as the milk reached 25°, 20°, 15°, 10°, 5°, and 0° C. and they were held at the corresponding temperature for periods of 14 and 24 hours, before testing the fat for acidity.

The data are shown in Figure 6. It is clearly evident that cooling after warming is an essential step in the activation process. The full effect of

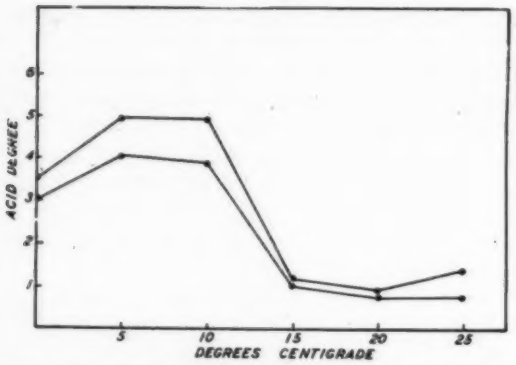

FIG. 6. The relation of the storage temperature of activated milk, and the acid degrees after 14 and 24 hours. The higher values were obtained after 24 hours storage.

warming does not appear unless the milk is subsequently cooled below 15° C.

It must be remembered that two factors are involved in this experiment. It seems reasonable to suppose that the hydrolysis itself (assuming uniform activation) would proceed more rapidly at the higher temperatures. However, the degree of activation might be greater at the lower temperatures, and this would mask the other factor. The experimental data seem to indicate this, since the rate of lipolysis passed through a maximum at a temperature of 5–10° C. However, there is not sufficient data to assert definitely that this is the explanation.

EXPERIMENT 7

The effect of hardness of the fat upon lipase action at a given temperature

It seemed probable that the degree of crystallization of the fat was an important factor governing the rate of lipolysis. The data suggest that, other factors being equal, solid fat is attacked more readily by lipase than liquid fat. This fact could be detected, with certainty, only if both samples of fat were held at the same temperature during storage.

In order to test this possibility, a sample of fresh milk was cooled in ice water to 0° C. Samples were taken at temperatures of 20°, 15°, 10°, 5°, and 0° C. as the milk cooled. The milk was then re-warmed, and a second series of samples was taken at the same temperatures during the heating. These samples were stored at the temperature at which they were taken, and the fat acidity was determined after 20 hours.

It should be noted that the pairs of samples taken at each temperature would differ principally in the degree of hardness of the fat. The fat of the sample which had been warmed from zero to twenty would be nearly solid while that in the sample cooled to 20 would still be liquid. None of these samples were activated by cooling after rewarming.

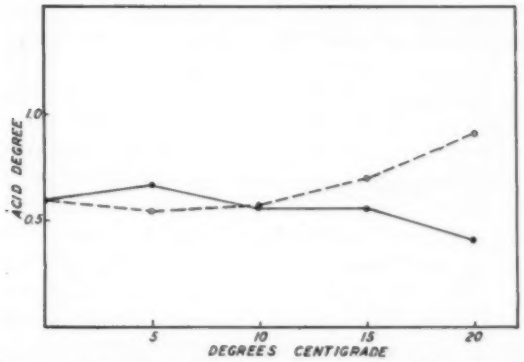

FIG. 7. A comparison of lipolysis of cooled and warmed fat when both are held at the same temperature. Samples represented by the solid line were cooled to the indicated temperature, those on the broken line were warmed from 0° C. to the indicated temperature.

The data are presented in Figure 7. It is apparent that at the higher temperatures the solid fat is attacked more readily than the liquid fat. At the lower temperatures, the reverse is true. The data suggest that there is an optimum degree of solidification for lipase action. If the fat is too thoroughly hardened, lipase action is retarded. This would not be incompatible with the observations made in the previous experiment. It merely indicates another factor which is partially responsible for the observed optimum temperature for lipolysis.

EXPERIMENT 8

The effect of fat hardness upon the degree of activation possible by warming

Since it appeared that these phenomena might be traced in part to the degree of hardness of the fat, it seemed of interest to learn if the degree of hardness of the fat at the time when the milk was re-warmed might be a factor. The data of Figure 5 seem to indicate that it is not, since the activation was not appreciably increased by holding for a longer time. In that experiment it was assumed that the fat held 15 minutes at 10° C., for example, would be more solid than that which was not held. However, in that experiment, the milk was cooled slowly (from 34° C. to 0° C. in 93 minutes) and it is possible that the increased hardening during such a short holding period was negligible.

In order to answer this question more definitely, a lot of fresh milk was cooled to zero and then re-warmed. Samples were taken during the cooling and again during the warming process. Each pair was held at its own temperature for 45 minutes, before activating by warming to 30° C. and cooling to 0° C. These samples were tested for free acid after 48 hours at 0–5° C. The data are presented in Figure 8.

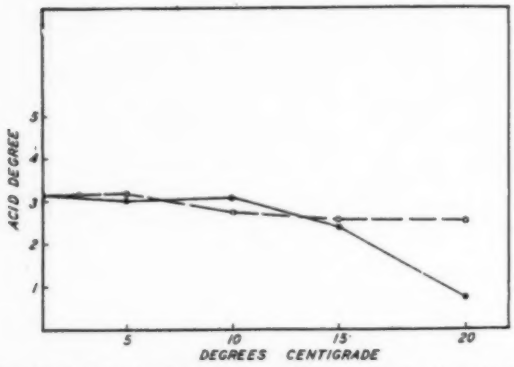

FIG. 8. The effect of fat hardness upon the degree of activation attainable by warming. Before activation, the milk was adjusted to the indicated temperature by cooling (or warming) and holding it for 45 minutes. Storage time 48 hours. Solid line represents cooling.

These results are more difficult to interpret than some of the others. Apparently the effect of low temperature cooling upon subsequent activation by warming is retained for some time even though the milk is stored subsequently at a higher temperature. The data do suggest that there is an optimum degree of pre-cooling for the activation by warming but the difference is too small to be conclusive. In order to learn how long the effect of low temperature cooling might be retained during storage at a higher temperature, this experiment was repeated using a twenty-two hour equilibration period instead of a forty-five minute period. The acid degrees of the different samples were determined at the time of activation and these were subtracted from the final values in order to obtain the increase after activation.

The results of this second experiment were practically the same as the first. The actual values were lower because of the shorter holding period after activation, but the shape of the curves was almost identical with those of Figure 8, showing that the effect of pre-cooling upon subsequent activation was retained, even at 20° C., for at least 22 hours. However, a slight loss of activatibility was apparent at the higher temperatures, amounting to about 10 per cent at 20° C. after 22 hours.

EXPERIMENT 9

The activation and deactivation of deactivated milk

In Experiment 1, Figures 1 and 2, it was shown that heating milk to 30° C. caused an activation of the lipase,[2] while continued heating to higher

[2] In this paper the expression "activation of lipase" is sed for convenience only. It seems probable that activation is more dependent upon changes in the state of the fat than upon changes in the lipase.

temperatures caused a deactivation. It seemed of interest to determine if milk could be activated again after it had been deactivated by heating to such a temperature that the lipase was not actually destroyed. For the purpose of this experiment, cold milk reheated to a temperature of 37° C. is termed deactivated; when reheated to only 30° C. it is considered activated. It should be noted that lipase "deactivated" in this way is only partially deactivated. It is still much more active than that in unheated milk.

A sample of fresh cold milk was "deactivated" and stored at 0–5° C. After twenty-one hours, the sample was divided into three portions. One was left as a control, one was deactivated a second time, and the third was activated as previously described. These samples were then stored at 0–5° C. for an additional period of twenty-one hours. The acidity of the fat was determined at the beginning of the experiment, at the time of activation and at the end of the experiment.

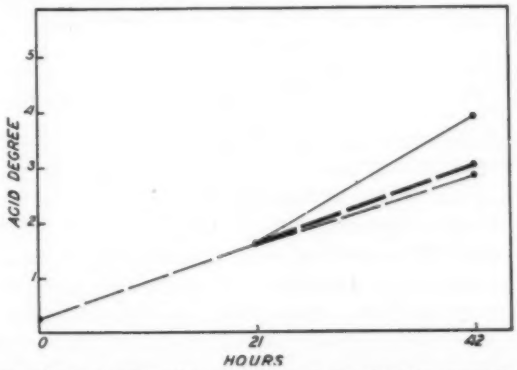

FIG. 9. The effect of activation, or a second deactivation, upon lipolysis in deactivated milk. Activated milk indicated by solid line, double deactivation by a double broken line.

The data are shown in Fig. 9. It is evident that the original sample of "deactivated" milk became rancid quite rapidly. This could be predicted from the results of Experiment One. It is also apparent that such milk can still be activated by proper heat treatment which indicates that the "inactivation" is not due to thermal destruction of the enzyme. The second "deactivation" actually increased the rate of lipolysis though not to so great a degree as by the activation procedure. This is possibly due to the fact that a fresh fat surface is exposed to the action of the enzyme when the fat droplets are melted.

EXPERIMENT 10

The activation and deactivation of activated milk

This experiment was similar to the preceding one, and the same supply of milk was used for both experiments. However, in this experiment, the

milk was activated in the beginning instead of being deactivated. Portions were reactivated and deactivated after twenty-one hours, as in the previous experiment.

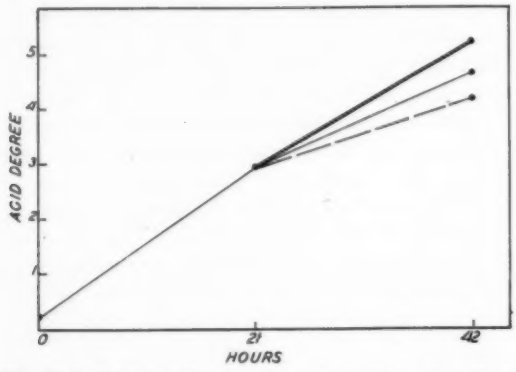

FIG. 10. The effect of deactivation, or a second activation, upon lipolysis in activated milk. Deactivated milk is indicated by a broken line, double activation by two solid lines.

The results of this experiment are presented in Figure 10. It is evident that during the first twenty-one hours, the lipolysis of the activated milk proceeded much more rapidly than in the deactivated milk of the preceding experiment. It is also evident that the "reactivation" was effective in stimulating lipase action. This might be explained by assuming that a fresh fat surface was exposed to the enzyme and water by heating the milk. However, other factors must be involved, because the "deactivated" milk was heated, also, and in that case lipolysis was retarded. Whatever the mechanism may be which is responsible for the phenomenon of activation, it is undoubtedly a reversible process.

EXPERIMENT 11

Showing the possibility of repeated activation of milk lipase

In the preceding experiment, it was shown that lipolysis in milk could be stimulated by a second activation. It seemed of interest to determine how many times the activation might be repeated and still cause a stimulation of lipolysis. In order to secure such information, a series of identical milk samples were prepared. One was used to determine the initial acidity of the fat. The remaining samples were activated at once and again after intervals of 24, 48, 72, 96, and 120 hours. After each interval, one sample was taken from the series for the determination of the fat acidity. This experiment was performed six times, using milk from a different cow for each series.

The data are presented in Figure 11. A few values are missing because it was exceedingly difficult to churn the fat in these highly rancid samples. In a few cases it was impossible.

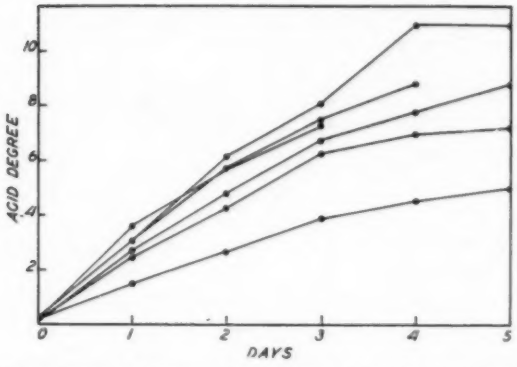

FIG. 11. The progressive increase in acid degree of milks reactivated every twenty-four hours.

In order to interpret the results of this experiment it is necessary to remember that lipolysis normally slows down considerably after the first twelve hours. This was shown in the first paper of this series, and it is shown again in Figure 6 of this paper. In contrast to this normal behavior, these data show that by repeated activation it was possible to secure an almost uniform rate of lipolysis during a period of 96 hours. The data do indicate that there is an upper limit to the acidity obtainable by repeated activation. However, this is of little practical importance because milk would become unmarketable long before such limiting values were even approached.

SUMMARY

Lipolysis in cold milk is accelerated by warming the milk slightly and re-cooling. To secure a maximum of activation, milk should be pre-cooled to 5° C. or lower, re-warmed to 30° C., and then re-cooled below 10° C. The length of time the milk is held at the pre-cooling temperature, or at the activation temperature, is of less importance than the actual temperatures employed, at least in the case of moderate rates of heating and cooling.

The rate of lipolysis seems dependent upon the crystalline state of the fat, and consequently upon the previous temperature history of the milk. Differences in previous temperature history are retained even at 20° C. for at least 22 hours.

Milk which has been activated can be reactivated or deactivated by suitable heat treatment.

These phenomena are of practical importance wherever raw milk is handled. It seems probable that this unrecognized phenomenon of activation has been responsible, in part at least, for many experimental results which have been attributed to other factors.

STUDIES OF LIPASE ACTION. III. LIPASE ACTION IN THE MILK OF INDIVIDUAL COWS

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Most of the data reported in the two preceding papers were based upon a study of mixed milk. However, the first paper did include data concerning the acid degrees of fresh milk from individual cows, and the second contained a comparison of the rates of lipolysis in the milk of a few individuals. This paper contains the results of a more extensive investigation of the milk of individual cows, and of certain factors which might influence the lipase content of milk. The data are published to show the extent of variation, and the complexity of the relations involved. At the present time, no attempt at interpretation can be made.

THE EXPERIMENT

Individual samples were taken from the milk of the 61 cows in the dairy herd of this University at the afternoon milking of either November 27 or December 3. The acid degrees of the fat were determined at the time of milking, and after the milk had been held 24 hours at 0–5° C. A portion of the milk was activated by cooling to 5° C. and rewarming to 30° C., and the acid degree was determined after 24 hours storage at 0–5° C. Another portion was treated with formalin (1 ml. per qt.), activated, and then tested after 24 hours storage at 0–5° C.

From these data, information may be obtained regarding: first, the normal acidity of the fat at the time of milking; second, the variation in the rate of lipolysis of different samples of milk while it is held cold; third, the variation in response to the activation procedure; and fourth, the relative importance of the formalin-sensitive, and the formalin-tolerant lipases in different samples of milk. For comparison with these data, records were kept of the stage of lactation and gestation, and of the yield of milk obtained at the milking from which the samples were taken. (These cows were being milked three times daily at approximately eight-hour intervals.)

All of these data are assembled in Table I. The cows of each breed have been segregated, and arranged according to stage of lactation. To a certain degree, this also arranged them according to stage of pregnancy and milk production.

A study of these data shows that there is little correlation between the stage of lactation and the development of rancidity in milk, with or with-

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TABLE 1

A study of lipase action in the milk of 61 individual cows

Cow no.	Weeks of lactation	Pounds of milk	Weeks of gestation	Acid degree			
				Untreated		Activated held 24 hours	Treated with CH_2O activated, held 24 hours
				Fresh	Held 24 hours		
Holsteins							
50	6	27.1		.35	.90	1.79	1.59
55	6	21.5		.25	.40	1.41	.59
43	7	20.3		.33	.70	1.60	1.51
42	7	20.7		.23	.80	2.16	.71
48	8	17.1		.29	1.46	2.34	1.22
36	9	23.5	2	.28	.59		1.89
56	10	18.6		.32	.63	1.86	1.10
58	17	10.8	3	.28	1.60	2.50	.92
37	18	19.5		.25	1.71	2.93	1.42
35	19	20.2	[illegible]	.36	.70	2.20	.82
41	22	18.5	[illegible]	.32	.49	1.81	1.04
44	23	13.3	3	.26	.43	1.13	.79
49	27	17.0	17	.27	.80	2.21	.63
51	29	15.7	2	.30	.94	1.71	1.51
59	34	12.9	21	.26	.86	2.55	1.22
47	35	10.2	20	.30	.60	1.78	.58
38	38	10.2	24	.29	1.36	2.39	1.20
52	41	14.4	21	.27	1.46	1.89	1.48
40	42	4.9	17	.28	.27	.75	.74
46	43	8.7	23	.21	.87	2.70	1.07
45	45	15.2	35	.19	.28	1.76	.55
39	49	6.9	25	.28	1.03	3.50	1.37
Guernseys							
14	3/7			.13	.20	.36	.29
33	3	21.0		.21	.99	1.38	
22	3	19.7		.38	1.89	3.29	
29	4	14.2		.20	.41	2.13	1.89
12	6	9.0		.20	.25	2.20	.48
17	17	10.6		.21	1.20	2.83	2.76
57	18	7.3		.32	1.56	2.84	1.78
13	21	8.2	5	.20	.40	1.85	.61
16	32	9.2	21	.20	.80	3.68	1.89
1	38	6.8	24	.20	.31	1.70	.27
11	41	5.0	32	.30	.45	3.75	.91
18	51	15.7	3	.28	.40	3.00	.41
34	60	7.7	8	.23	1.48	3.07	1.55
Jerseys							
7	5	7.1		.15	.55	1.89	.59
10	7	15.7		.30	1.19	3.55	3.50
25	14	11.9	3	.19	.45	2.51	1.76
28	38	8.3	17	.20	.50	2.88	.39
32	39	1.9	14	.30	2.48	3.31	1.01
2	40	4.1		.20	.40	1.59	.29
6	41	6.3	25	.25	2.06	4.89	1.17
3	44	8.8	15	.20	1.54	4.31	1.48
31	44	12.0	2	.20	1.30	1.81	2.17
27	47	4.5	24	.20	1.79	4.11	1.69
30	52	4.5	16	.30	2.21	5.08	2.92
26	60	2.8	4	.19	.75	2.30	1.26

TABLE 1—(*Continued*)

A study of lipase action in the milk of 61 individual cows

Cow no.	Weeks of lacta-	Pounds of milk	Weeks of gesta- tion	Acid degree			
				Untreated		Activated held 24 hours	Treated with CH_2O activated, held 24 hours
				Fresh	Held 24 hours		
Ayrshire							
20	8	19.7		.20	.39	2.10	1.59
54	15	9.5	5	.16	.56		1.70
19	23	11.7		.19	.30	2.14	1.27
24	43	5.2	9	.13	1.41	3.41	2.52
21	45	7.2	9	.22	1.14	3.40	1.90
15	45	1.6	4	.21	.50	1.96	
53	47	3.9	1	.21	.40	1.30	.43
23	48	3.9	6	.21	.40	2.30	.75
Brown Swiss							
4	2	16.4		.30	.41	1.71	1.33
8	30	8.9	21	.37	.79	2.71	1.74
9	35	11.2	13	.33	.46	3.60	1.09
5	36	10.1	25	.30	2.33	7.73	3.17
60	78	4.7	22	.23	.36	.75	.22

out activation. Similarly, there is no apparent correlation between the stage of gestation, or of milk production with lipase action. There is some evidence of correlation between the rates of lipolysis with and without activation (coefficient of correlation = + .385) but even in this case it is apparent that several factors must be involved and that the relations are not so simple as might be supposed.

These data show that there is a great deal of variation in the nature of the lipases present in different milks, as well as in the apparent amount. For example, the milk of cows 43, 40, 17, and 10 contains principally the

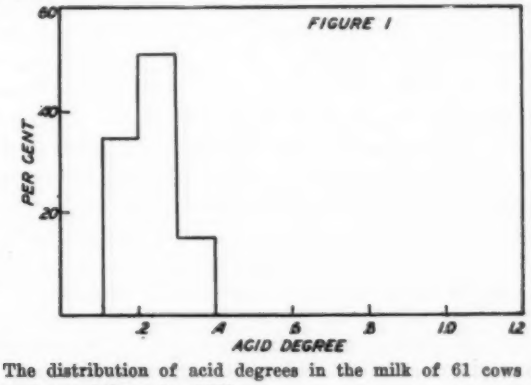

FIG. 1. The distribution of acid degrees in the milk of 61 cows at the time of milking. November and December 1937.

formaldehyde resistant lipase, while that of cows 1, 2, 18, 28, and 60 contains relatively little of this enzyme in comparison with the amount of the formaldehyde sensitive lipase. Most of the samples contain both enzymes, but the proportions in which they occur vary widely.

The fact that in milk there are at least two lipases possessing different properties may be responsible for the fact that so little progress has been made in the study of lipolysis in milk. By studying the behavior of these enzymes separately, it may be possible to explain some of the apparent inconsistencies in our present knowledge.

For comparison with the distribution of acidities of milk fat at the time of milking which was published in the first paper of this series, a similar chart (Figure 1) was prepared from the data of Table 1. It is apparent that the distribution is very similar to that found six months earlier (May). Nearly all of the samples of fresh milk fat which have been examined up to the present time have had acid degrees between 0.15 and 0.35.

SUMMARY

A study was made of lipolysis in the milk of 61 individual cows. A great deal of variation was found in the rates of lipolysis in different samples, and in the response of different samples to activation by warming and cooling. There was no apparent correlation between the rates of lipolysis and the stage of lactation, the stage of gestation, or the milk production of the individual cows.

In some of these samples, the formaldehyde-tolerant lipase predominated; in others, the formaldehyde-sensitive enzyme was more important. Most of the samples contained both enzymes.

STUDIES ON THE ACTIVATED FLAVOR OF MILK

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INTRODUCTION

The specific flavor defect which may be apparent in milk unduly exposed to ultra-violet radiation has been referred to as "activated flavor" by Weckel, *et. al.* (15, 16, 17). The flavor may be described by the terms "burnt," "burnt protein," or "burnt feather." It has also been described as "mushroom flavor" since it is sometimes characteristic of that observed in mushroom soups or broths (17). The flavor may be intensified by heating the irradiated milk to 180° F. or greater followed by cooling. The activated flavor is not to be confused with other flavors such as tallowy, oxidized or cardboard flavors, which may develop in milk following the action of light.

Weckel and Jackson (17) have indicated from their own work and from a comprehensive review of the work of other investigators that the flavor is due to the action of light on the protein fraction of milk. Their review includes the work of Rohr and Schultz (5, 6, 7, 8) who have reported an abnormal flavor in milk which they attributed to the effects of radiation on proteins. They also note the work of Bovie (1), Clark (2), and Stedman and Mendel (9), who have found that the irradiation of various proteins or their solutions leads to the development of "peculiar" or "burnt" odors. The change in character of the absorption spectra of irradiated as compared with non-irradiated solutions of protein, protein derivatives, and amino acids is claimed to be indicative of a significant photochemical effect (17).

On the other hand Doan and Myers (3) indicate that the "burnt flavor" caused by the action of sunlight on milk has its origin in the casein-free and albumin-free serum of the milk. These workers found that a distinct "burnt flavor" developed in this serum when exposed to the sunlight. They call attention to the coincidence between development of this flavor and the fading in color of the serum pigment, lactoflavin.

It has been inferred by Weckel and Jackson (17) that the activated flavor observed in unduly irradiated milk is identical with the burnt flavor observed in milk and skimmilk exposed to sunlight. Hammer and Cordes (4) noted that "off" flavors were developed in certain samples of milk after only 10 minutes exposure to sunlight. Tracy (10) has reported that

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* The authors gratefully acknowledge the assistance given by Mr. H. H. Beck in tasting the samples.

continued exposure of milk to sunlight results in a burnt flavor. The development of such flavor in cottage cheese either within or without glass containers exposed to sunshine has been noted by Tracy and Ramsey (11). Development of the flavor in milk has also been observed by Doan and Myers (3) and by Tracy and Ruehe (12).

Ultra-violet radiation is extensively used for increasing the antirachitic potency of market milk. Since improper use of irradiation may bring about development of the activated flavor, studies were instigated to determine the conditions under which the flavor develops and some of the characteristics of the flavor. A study was likewise made of the burnt flavor which develops in milk on exposure to sunlight, involving a comparison between this flavor and the activated flavor of irradiated milk.

EXPERIMENTAL PROCEDURE

Irradiation of the milk with a strong ultra-violet source was carried out in 200 ml. portions in stainless steel pans 18 cm. square and 3 cm. deep. The pans were placed on a small platform which was given a constant rocking motion by means of an electric motor. The source of ultra-violet light was a Hanovia quartz mercury arc placed directly above the pans at a distance of 76.5 cm. The intensity of the light was approximately 700 microwatts per square centimeter per second at the surface of the film of milk, and was maintained by means of a Hanovia photocell Englehard meter circuit. Subsequent to exposure to radiation the various samples were heated to 180° F. then cooled, since this procedure intensifies the activated flavor. The samples were then examined for intensity of this activated flavor.

The various flavor examinations were made independently by three experienced milk judges.

It was found that with the conditions being used in these experiments an exposure time of seven minutes was sufficient to cause a distinct although not especially strong activated flavor and odor. A strong flavor was undesirable since it was not conducive to accurate distinction between samples.

For the study of the effect of sunlight on the flavor of milk, samples were exposed in 50 ml. portions in stainless steel pans 7.5 cm. square and 2.5 cm. deep. Examination for the flavor was ordinarily made on the unheated milk, but the comparison of these samples with ultra-violet irradiated samples was also made after heating the exposed milk to 180° F. and cooling.

RESULTS OF EXPERIMENTS

A. *The Effect of Heating Milk to Various Temperatures Previous to Irradiation on the Development of Activated Flavor*

Since the heating of milk that has been unduly exposed to ultra-violet radiation intensifies the activated flavor, it was thought desirable to study

the effect of heating the milk to various temperatures previous to irradiation on the development of flavor in the subsequently exposed samples.

From Table 1 it is evident that pasteurization of milk does not augment the intensity of the flavor. However, preheating milk to temperatures of

TABLE 1

Effect of temperature to which milk is heated upon its susceptibility to development of activated flavor[a]

Temperature to which milk is preheated, °F.	Relative flavor intensity
Unheated	½
143.5	½
150	1
165	1½
185	2
200	2

[a] Milk preheated to temperatures shown, cooled to 70° F., uniformly irradiated, then heated to 180° F., cooled and sampled.

150° F. to 200° F. resulted in a slightly greater intensity of flavor in the milk subsequently exposed to radiation. This difference was not great but, in general, the higher the temperature the more marked was the effect. This indicates that heat has an effect on development of activated flavor even though the heating be done previous to irradiation. However, even with these preheated milks, heating subsequent to exposure to radiation was necessary to bring out the typical flavor under the conditions of these experiments. The samples which had been preheated to 185° F. and 200° F., respectively, possessed an "ozone flavor" without further heating. The ozone flavor is similar to the odor of ozone frequently observed in the vicinity of spark gaps.

B. *Effect of Homogenization on Activated Flavor*

Due to the fact that homogenized irradiated milk has come into favor, it was thought advisable to study the effect of this double processing on the flavor of milk. An effort was made to determine whether or not homogenization has any effect on the susceptibility of milk to development of activated flavor when unduly exposed to radiation. In general, the results indicate that when irradiation and homogenization are both used in processing milk better results are secured if irradiation precedes homogenization. A but slightly more intense flavor resulted when homogenized milk was irradiated than when milk was irradiated only, or irradiated and then homogenized. Homogenized milk seems to be slightly more susceptible to development of activated flavor when exposed to sunshine than is unhomogenized milk. Perhaps the parent substance or substances which give rise to the flavor may be made more available to, or more susceptible to, the action of the ultra-violet rays and to the sunlight by the homogenization process.

C. *Effect of Altering the "Salt Balance" of Milk upon the Development of Activated Flavor*

Experiments were conducted in which different amounts of various salts were added to milk previous to exposure to radiation to determine whether a disturbance in the normal "salt balance" of the milk might cause an increase or a decrease in intensity of the activated flavor.

When various amounts (0.5 to 5 ml. of molar solutions) of sodium citrate, di-sodium phosphate, calcium acetate, calcium chloride, calcium lactate, or di-basic calcium phosphate were added to 200 ml. portions of milk no definite increase or decrease in flavor intensity was found if the mixtures were then irradiated.

Various sulfur compounds were also added to milk at the rate of 0.25 to 2 ml. of molar solutions per 200 ml. of milk before exposing the milk to radiation. Neither sodium sulfate or sodium thiosulfate had any marked effect on intensity of the activated flavor. No activated odor could be detected in irradiated milk to which had been added sodium sulfite or sodium bi-sulfite. This treatment imparted a strong odor of hydrogen sulfide to the milk and prevented its being tasted. It could not be determined whether the development of the activated odor was being prevented by the compounds added, or whether the odor was merely masked by the hydrogen sulfide.

D. *Effect of Oxidizing Milk on the Stability of the Activated Flavor*

In the course of studies to determine the susceptibility of irradiated milk to development of tallowy or oxidized flavor, it was noticed that samples to which had been added small amounts of copper and which were being held at 40° F., showed a gradual lessening in intensity of activated flavor. Since copper is known to be a catalyst of oxidations, it was thought advisable to investigate the possibility of removing the activated flavor from milk by oxidation.

The addition of a small amount of hydrogen or calcium peroxide either before or after irradiation caused a marked decrease in intensity of flavor. The hydrogen peroxide imparted a somewhat bitter flavor to the milk, while in the calcium peroxide treated samples there was a perceptible lime flavor. It is possible that the activated flavor was being partially masked by these foreign flavors, but the opinion of the judges was that the flavor was actually decreased by addition of the peroxides.

Removal of the activated flavor was accomplished by adding two to three parts per million of copper to the irradiated milk followed by bubbling air through the milk either at room or higher temperature. The best results with this method were secured by holding the milk at 140–145° F. for 30

minutes and bubbling air through it during this interval. Oxidized flavor eventually developed in the milk given this treatment when it was cooled and held at 40° F., but only after 36 to 48 hours.

These experiments in which the activated flavor was removed from milk by oxidation seem to indicate that the compound responsible for the flavor is comparatively easily oxidized, and that oxidation destroys its flavor producing characteristics. However, Swanson and Weckel (14) have found that the addition of oat flour, an anti-oxidant, resulted in decreased susceptibility of the milk to development of activated flavor when compared with untreated samples similarly exposed to radiation. They also observed that milk from cows in early stages of lactation is less susceptible to development of the flavor than is milk from cows that are well advanced in their lactation period.

It is interesting to note that the production of activated flavor by either sunlight or artificial ultra-violet radiation is inhibited when nitrogen is used to replace the usual gas balance existing in milk. Swanson and Weckel (14) removed the air from milk in pyrex flasks by suction. The air was replaced by nitrogen bubbled through the milk. Three evacuations and replacements by nitrogen were made. The periods of the nitrogen treatment were, respectively, five, fifteen and thirty minutes. An atmosphere of nitrogen over the milk was obtained, and the flasks sealed. Flasks of milk not treated by evacuation and nitrogen were similarly sealed.

Exposure of these samples of milk to sunlight on a cloudy day for one hundred forty minutes resulted in the development of a strong activated flavor in the untreated samples of milk, but no activated flavor in the samples of milk treated with nitrogen. When samples of milk prepared in a manner similar to that described above were exposed to radiation from a mercury vapor lamp, inhibition of the development of the activated flavor in the sample treated with nitrogen was again observed, although the inhibition was not as great as in the samples exposed to sunlight.

E. *Effect of Exposure of Solutions of Gelatin and of Egg White to Radiation*

Since it is believed (17) that the protein fraction of milk is the parent substance of the activated flavor, it was thought desirable to study the action of ultra-violet light upon solutions of some proteins other than those derived from milk. Two hundred ml. portions of a one per cent aqueous solution of gelatin were exposed to radiation for various lengths of time. Exposures of five to seven minutes produced a slight activated flavor, and exposures of ten to fifteen minutes produced a characteristic activated flavor when the solutions were subsequently heated to 180° F. and cooled.

The addition of one-third the "white" from one egg to 200 ml. of milk followed by exposure to radiation produced a slightly greater activated odor than was present in control milk to which no egg white had been added. However, the difference was not marked. Half the white of an egg, made up to 200 ml. of solution with water, and given the usual irradiation and heat treatment, resulted in a slight activated odor. (These samples were not tasted for *psychic* reasons, hence the observations reported are of odors only.)

F. *Studies on the Burnt Flavor that Develops in Milk Exposed to the Sunlight*

As stated above, since previous workers (17) have inferred that the activated flavor of irradiated milk is identical with the burnt flavor that develops in milk exposed sufficiently to sunshine, it was considered advisable to compare the two flavors. The flavor studied was the activated, or burnt flavor, and is to be distinguished from the oxidized flavor resulting from the action of light on fats. The oxidized flavor was frequently observed in the course of this work. The flavor of samples of milk exposed to ultra-violet radiation for various lengths of time was compared with that of samples which had been exposed to sunlight for different periods of time. The flavor comparisons were made of the unheated samples and also of samples heated to 180° F. and cooled.

The flavors were found to be strikingly similar, and it was believed by the judges that they were either identical or practically so. Exposures of 50 ml. samples to direct sunlight in 7.5 cm. square stainless steel pans produced the flavor in as little as 10 minutes time. When the milk was heated to 180° F. and cooled previous to tasting, the flavor was detectable in samples which had been exposed only 5 minutes. This is especially interesting in that, as has already been pointed out, the flavor which results from ultra-violet radiation is also enhanced by heating the milk to 180° F. or greater. It is evident from the present work as well as that of previous investigators that ordinary glass as used in milk bottles does not prevent development of the activated flavor due to sunlight. Doan and Myers (3) found that the flavor development was retarded by blue and green colored paper bottles and by blue and green cellophane wrappers on paper bottles. They observed this retarding effect using skimmilk, whole milk, cream and buttermilk.

Various colored glass filters of known wave length transmission values (Corning Glass Company) were used in an attempt to determine the wave length characteristics of radiation which are most effective in causing development of the burnt or activated flavor. These filters along with their transmission ranges are listed in Table 2.

TABLE 2

Relation between development of activated flavor in milk exposed to sunshine and transmission characteristics of glass filters

Glass filter (Corning)		Transmission characteristics (Ångstrom units)	Relative intensity of activated flavor
Red Purple Corex A	986	2640–4060	3
Blue Purple Ultra	585	3800–4760	3
Signal Green	440	3820–5960	2
H. R. Lantern Blue	554	3930–5000	2
Noviol Shade C	338	4580–7100	1
Sextant Green	401	4660–5960	1
H. R. Lantern Shade Yellow	349	5460–7100	1
H. R. Signal Red	243	6100–7040	1
Clear Window Glass		3100–	3

The relative amount of flavor development which each of the filters allowed when placed over 50 ml. samples of milk in the 7.5 cm. pans and exposed to sunlight is shown in the table. Four of these filters, Noviol Shade C., Sextant Green, H. R. Lantern Shade Yellow, and H. R. Signal Red, were very effective in inhibiting development of the activated flavor. Exposures of one hour in direct sunlight failed to produce to any significant degree the typical flavor. The other four filters, Red Purple Corex A., Blue Purple Ultra, Signal Green, and H. R. Lantern Blue were less effective in preventing development of the flavor; the first two mentioned being the least effective of all. Each of these four filters allowed development of the flavor within 30 minutes exposure to direct sunlight.

The relative transmission ranges of the four filters which definitely inhibited development of the flavor are 4580–7100 Å, 4660–5960 Å, 5460–7100 Å, and 6100–7040 Å, respectively. The ranges of the less effective filters are 2640–4060 Å, 3800–4760 Å, 3820–5960 Å, and 3930–5000 Å, respectively. The results show that filters which eliminated all wave lengths less than 4600 Å were very effective in preventing development of activated flavor in milk exposed to sunlight. This would indicate that if milk bottles can be devised which will have transmission values comparable to that of the effective filters development of activated flavor in milk exposed to sunlight can be minimized.

The same filters were used with homogenized milk with the same general results except that homogenized milk tends to develop the flavor somewhat more quickly than does regular milk. These experiments were repeated using as filters various types of colored cellophane held between pieces of pane-glass (combined thickness about 0.2 to 0.3 cm.). The transmission characteristics of the cellophanes have been reported by Stebnitz and Sommer (13). Dark green, tango, and dark red were found especially effective, dark blue considerably less effective, while pink, and ordinary parch-

ment were still less effective in inhibiting the development of activated flavor in the milk. The first three colors mentioned prevented development of the flavor in milk exposed to direct sunlight for 30 minutes, while the others allowed development of a definite activated flavor within this 30 minute exposure period. This shows that the darker colors of cellophane are more effective than are the lighter colors in preventing development of activated flavor.

SUMMARY

These studies indicate that heating milk to temperatures above 150° to 160° F. and cooling enhances the activated flavor of the subsequently unduly irradiated milk. When irradiation and homogenization are both used in processing milk better results are secured if irradiation precedes homogenization.

Altering the "salt balance" of the milk by addition of various substances failed to increase or decrease the flavor intensity of the subsequently irradiated milk. Nitrogen and Avenex inhibited development of the flavor.

It was found possible to remove the activated flavor from milk by oxidation. This was best accomplished by adding to the irradiated milk two to three parts per million of copper and then bubbling air through the milk at 140–145° F.

The typical activated odor was produced by irradiation of aqueous solutions of egg white or of gelatin giving additional evidence that the protein fraction of milk is probably the parent substance of the flavor.

The studies indicate that the activated flavor of milk unduly exposed to ultra-violet radiation is identical or practically identical with the burnt flavor which develops in milk exposed to sunlight. Evidence is given that if milk bottles can be devised which will eliminate all wave lengths of light less than 4600 Å they will be effective in inhibiting development of the activated flavor caused by exposure of milk to sunlight.

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DICHLOROFLUORESCEIN AND POTASSIUM CHROMATE AS INDICATORS IN THE ARGENTOMETRIC ESTIMATION OF SALT IN BUTTER

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Potassium chromate has long been used as the indicator in the argentometric estimation of the sodium chloride content of solutions prepared in the analysis of butter according to the method of Kohman (4) as recommended by the Subcommittee on Butter Analysis of the American Dairy Science Association (1). Recently, Bryant (2) has suggested the substitution of the adsorption indicator, dichlorofluorescein, for potassium chromate as the titration indicator. Whereas potassium chromate solutions undergo a color change from yellow to orange-red and thence "brick-red," upon the addition of silver nitrate, salt solutions containing dichlorofluorescein undergo color transition from greenish-yellow fluorescent through whitish opalescent to pink. Under certain conditions the transition of the yellow to orange-red color in the chromate-silver nitrate reaction has not been considered sufficiently critical to permit sharp distinction of the colors. This lack of distinction may easily lead to utilization of an improper end point in the reaction, with accompanying error in the analysis. Hunziker specifically cautions, for example, against excess titration (3). Bryant has observed that the color change from white or whitish appearance to pink state is sudden, and, further, that the results obtained with the fluorescein dye are less (approximately 0.1 per cent salt equivalent) than when potassium chromate is used.

The results obtained using the two indicators, dichlorofluorescein and potassium chromate, when determining the salt content of solutions prepared in the routine analysis of butter received at the Department of Dairy Industry, and in experimental comparisons, are presented to indicate the differences which occur by use of the two methods.

PROCEDURE

In the colorimetric titration of sodium chloride with silver nitrate two factors, at least, may affect the accuracy of the measurement. When the concentration of sodium chloride in the solution is relatively small, the definition of the color end-point may be wanting; when the concentration of silver nitrate in the titrating reagent is relatively great, the ease with which a given color end-point may be developed is limited, and errors acquired in reading the burette have magnified values. The influence of these was con-

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sidered in part by the use of a standard dilution of sodium chloride, *i.e.*, the salt dissolved in 250 ml. of water, the employment of either 17.6 or 25 ml. portions of salt solution for purposes of titration, and silver nitrate solutions of such concentrations that readings as per cent sodium chloride could be obtained either directly from the burette or quickly computed. The following table summarizes the combinations used:

TABLE 1

Summary of procedures used in determining concentration of salt in butter

Method	Quantity of water in which salt from 10 grams of butter was dissolved	Quantity of salt solution used for titration	Silver nitrate per liter of solution	Factor for converting burette readings in mls. to per cent salt
	ml.	*ml.*	*grams*	
A	250	17.6	4.0915	÷ 5
B	250	25.0	5.812	÷ 5
C	250	17.6	20.4	X 1

In the titrations utilizing potassium chromate, the color end point used was that of the first permanent orange-red color. In the titrations utilizing dichlorofluorescein the color end point used was that of the first permanent pink color. A 10 per cent aqueous solution of potassium chromate, and a 0.1 per cent solution in 70 per cent ethyl alcohol of dichlorofluorescein (British Drug Houses Adsorption Indicator No. 22010) were used. Either of two quantities, 2 drops or 0.5 ml., of the indicators were employed, as indicated.

RESULTS

The results of the tests using the two indicators in routine analyses of butter received at the University Creamery are given in Tables 2 and 3.

The results of the titrations for salt in butter using the three methods outlined in Table 1 are given in Table 2. It is evident that in each series where the two indicators were compared, the mean of the titrations using dichlorofluorescein is less than the mean of the titrations using potassium chromate. A lesser difference between the means of two series of titrations using the two indicators occurred when 17.6 ml. of a solution of the salt from ten grams of butter dissolved in 250 ml. was titrated by a solution containing 4.0915 grams silver nitrate per liter.

The variability of the results of titrating a single salt solution repeatedly using first the potassium chromate and then the dichlorofluorescein is shown in Table 3. In this experiment the salt solution was prepared from a single sample of butter and the titrations were made using 17.6 ml. of salt solution

TABLE 2

Percentage of salt in various samples of butter as determined when using 2 drops of indicator solution

Sample No.	Potassium chromate	Dichloro-fluorescein	Difference between indicators	Potassium chromate	Dichloro-fluorescein	Difference between indicators	Potassium chromate	Dichloro-fluorescein	Difference between indicators
	Method A			Method B			Method C		
	(a)	(b)	Difference (a)−(b)	(c)	(d)	Difference (c)−(d)	(e)	(f)	Difference (e)−(f)
12	2.54	2.45	.09	2.53	2.45	.08	2.55	2.45	.10
20	1.54	1.46	.08	1.58	1.48	.10	1.60	1.52	.08
51	2.40	2.42	−.02	2.41	2.40	.01	2.50	2.40	.10
89	2.57	2.50	.07	2.54	2.46	.08	2.52	2.50	.02
52	1.76	1.70	.06	1.76	1.68	.08	1.75	1.70	.05
67	2.12	2.08	.04	2.10	2.08	.02	2.13	2.10	.03
15	2.06	2.00	.06	2.05	1.99	.06	2.05	2.00	.05
21	2.16	2.12	.04	2.16	2.10	.06	2.15	2.10	.05
53	1.33	1.30	.03	1.32	1.30	.02	1.31	1.30	.01
97	2.01	1.95	.06	2.00	1.95	.05	2.00	1.95	.05
50	2.53	2.46	.07	2.52	2.46	.06	2.50	2.45	.05
90	1.79	1.76	.03	1.79	1.74	.05	1.80	1.80	.00
14	2.24	2.21	.03	2.24	2.20	.04	2.25	2.25	.00
82	1.22	1.18	.04	1.22	1.16	.06	1.25	1.20	.05
91	2.32	2.30	.02	2.33	2.27	.06	2.30	2.25	.05
92	2.47	2.48	−.01	2.46	2.46	.00	2.45	2.45	.00
16	2.52	2.52	.00	2.49	2.52	−.03	2.50	2.50	.00
0	1.84	1.79	.05	1.83	1.84	−.01	1.85	1.84	.01
Mean	2.079	2.038		2.074	2.030		2.080	2.042	

TABLE 3

Percentage of salt in a sample of butter as determined when using two drops and 0.5 ml. of potassium chromate and dichlorofluorescein indicators

(Two drops of indicator)		(0.5 ml. indicator)	
Potassium chromate	Dichloro-fluorescein	Potassium chromate	Dichloro-fluorescein
2.25	2.20	2.30	2.24
2.26	2.20	2.30	2.23
2.28	2.20	2.28	2.20
2.26	2.20	2.30	2.21
2.27	2.20	2.32	2.20
2.24	2.19	2.31	2.21
2.25	2.20	2.35	2.21
2.27	2.21	2.28	2.20
2.23	2.20	2.30	2.19
2.26	2.20	2.32	2.20
2.24	2.20	2.30	2.20
2.28	2.20	2.30	2.20
2.26	2.18	2.28	2.21
2.27	2.20	2.32	2.20
2.28	2.20	2.31	2.19
Mean 2.260	2.198	2.304	2.206
Probable error of mean — ± .0027	± .0007	± .0031	± .0022

and silver nitrate solution containing 20.4 grams per liter. The differences between the means shown in this table are statistically significant.

The variability of the results of titrating a single salt solution prepared from recrystallized sodium chloride with silver nitrate solution using first potassium chromate and then the dichlorofluorescein as indicators is shown in Table 4. The differences between the means of the titrations shown in this table are statistically significant. The results of the titrations using dichlorofluorescein were in much better agreement with the calculated percentage sodium chloride of the solution than when potassium chromate was used.

The results of the titrations by a student of a salt solution prepared from butter using first potassium chromate and then dichlorofluorescein as indicators are given in Table 5. The student was asked to make repeat titrations of the solution and was given but two demonstrations of the color end-point of the two indicators. The difference between the means of the two series of titrations in this table also is statistically significant.

Wellings has concluded that the quantity of the adsorption indicator to be used in an argentometric halide titration must lie below the value of 5×10^{-3} mol of indicator per one mol of silver halide, and the concentration as far below this limit as possible, as the color intensity of the titration system is often influenced by the scattering of light caused by the dispersed absorbent (5). In general, it is suggested a concentration of 1×10^{-3} mol

TABLE 4

Percentage of salt in a salt solution as determined when using potassium chromate and dichlorofluorescein indicator (salt solution prepared quantitatively, 3% NaCl)

Potassium chromate	Dichlorofluorescein
(a)	(b)
3.10	3.00
3.10	3.00
3.09	3.01
3.10	3.01
3.10	3.00
3.10	3.00
3.10	3.01
3.08	3.00
3.10	3.00
3.10	3.01
3.10	3.01
3.11	3.02
3.08	3.00
3.10	3.01
3.10	3.01
Mean 3.0973	3.006
Probable error of mean ..... ± .0013	± .0011

of indicator per one mol of precipitate (or equivalent body) may be used as a practical value.

The color change of the reaction mixture may be influenced by the rapidity with which the titration is conducted. The absorption of light by

TABLE 5

Percentage of salt in a salt solution as determined by student using potassium chromate and dichlorofluorescein indicators

Potassium chromate	Dichlorofluorescein
2.57	2.56
2.55	2.54
2.58	2.58
2.55	2.52
2.60	2.51
2.60	2.57
2.55	2.55
2.59	2.57
2.60	2.58
2.60	2.55
2.60	2.56
2.60	2.54
2.59	2.59
2.60	2.52
2.58	2.51
Mean 2.584	2.550
Probable error of mean ..... ± .0035	± .0048

metal halides is influenced by the absorption of the indicator ions. While these facts may be significant under specific conditions, the results of titrations shown in Table 6 of a salt solution prepared from butter using di-

TABLE 6

Influence of lapse of time after addition of dichlorofluorescein indicator on results of titration

Sample No.	Time elapsing after indicator plus approximately one-half necessary silver nitrate was added to salt solution (Minutes)	Salt, per cent
1	0	2.95
	5	2.97
	10	2.97
	15	2.95
2	0	2.10
	5	2.10
	10	2.12
	15	2.10
3	0	1.52
	5	1.52
	10	1.54
	20	1.52

chlorofluorescein as the indicator and allowing a lapse of time during the titration indicate that when carried through with reasonable promptness variations of significance may not be anticipated.

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AN INSTANTANEOUS STEAM GENERATOR FOR "STERILIZING" MILK UTENSILS ON THE FARM

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Investigations by Russell (7) Kelly (2) Prucha, Weeter, and Chambers (5) Prucha and Harding (6), and others have shown the importance of sterile utensils in the production of high quality milk. Much of the legislation regarding milk production deals with the sterilization of all utensils with which the milk comes in contact. State laws and municipal ordinances now prescribe the sanitary conditions that must surround the production of retail milk. Bacteriological studies show that contaminated milk deteriorates so quickly as to be unfit for consumption at the time of delivery, or may be the source of infectious diseases.

The study here reported involves a new apparatus for generating steam to sterilize dairy utensils. The principle upon which it operates differs from the steam boiler in that water is vaporized while being pumped through coils heated with a fuel oil burner.

The object of this experiment was to determine the efficiency, cost, and convenience of this steam generator for the production of steam and hot water used in the washing and sterilizing of milk utensils on the dairy farm.

DESCRIPTION OF THE INSTANTANEOUS STEAM GENERATOR[2]

A ¼ H.P. electric motor is directly connected to a triplex pump, one cylinder of which pumps oil to the burner while simultaneously two cylinders of constant capacity pump water or solution to the generator coils (Figure 2). A vaporizing type of burner serves to heat the generating coils. The water in passing through the generator coils is heated to the temperature and pressure necessary to produce a thoroughly conditioned vapor. The manually adjustable burner valve controls the amount of fuel fed to the burner. Adjusting the burner valve to feed more or less fuel to the burner changes the ratio of fuel and water fed to the generator and makes the vapor wetter or drier as desired, regardless of the vapor pressure carried. An automatic pressure control switch shuts off the motor and stops vapor generation when the pressure reaches the desired set point. When the pressure drops slightly the switch closes and vapor generation is resumed. The unit may be operated

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[2] The steam generator used in this experiment was the "Hypressure Jenny," manufactured by the Homestead Valve Manufacturing Company, Coraopolis, Pa.

to produce anything from a steam and water mixture to a superheated steam. It is adjustable from 60 to 150 pounds of steam. This apparatus may also be referred to as a "flash boiler."

DESCRIPTION OF THE UTENSIL AND BOTTLE STERILIZING CHEST

A standard 48 inch by 58½ inch by 28½ inch upright steam chest[3] was used in this experiment. The chest was constructed of 20 gage galvanized iron and had one swinging door. The steam was admitted through a ¾ inch pipe, connected on the inside with two racks of six ¾ inch pipes. One of these racks of pipes was located at the bottom and the other near the middle of the chest. Two pipes on the bottom rack and two on the top rack were perforated with 1/16 inch holes. There were four holes in the pipes near the door and six in the pipes near the back of the chest on both the top and bottom racks. The other four pipes on each rack had no perforations and served only as a heating unit. The steam could be turned off from the perforated pipes without closing the steam to the closed pipes, which kept the utensils hot and thoroughly dried them without taking them out of the chest. Figure 3 shows the position of the pipes in the chest and the location of the steam jets in the pipes.

METHOD

This steam generator was first tested in the laboratory where it was used with the standard steam chest previously described. Cans, pails, strainers, and bottles were contaminated with milk cultures of three different common milk organisms, *i.e., Staphylococcus aureus, Escherichia coli,* and *Bacillus subtilis.* The milk cultures were prepared using one liter portions of sterilized skimmilk inoculated with pure cultures of these organisms. Approximately 24 hours after inoculation, samples of the cultured milk were taken to determine the number of bacteria per cubic centimeter. Contamination was effected by pouring the suspension of bacteria into the utensil to be sterilized. Immediately following the contamination, a one-liter portion of sterile saline solution was used to rinse the containers, except the bottles. A total count of this saline solution was made to determine the extent of contamination of these utensils.

After the containers were rinsed with the saline solution they were placed in the sterilizing chest to be steamed. Immediately after the steam was turned off, the door to the sterilizer was opened approximately 1 inch by the use of a notch cut in the latch. This allowed the steam to escape. Five minutes after the steam was shut off, the utensils were removed from the sterilizing chest and rinsed with one liter portion of sterile saline solution.

Milk bottles of quart, pint, and half pint sizes were contaminated and

[3] Sterilizing chest loaned through the courtesy of the Danzer Metal Works Co., Hagerstown, Maryland.

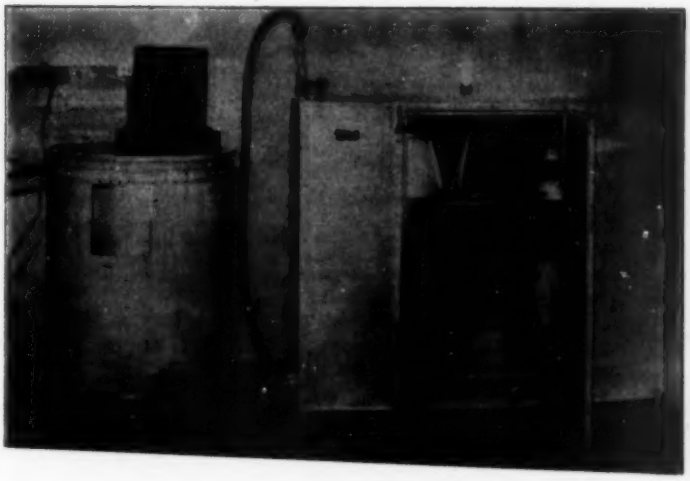

FIG. 1. Instantaneous steam generator and steam chest used in this experiment.

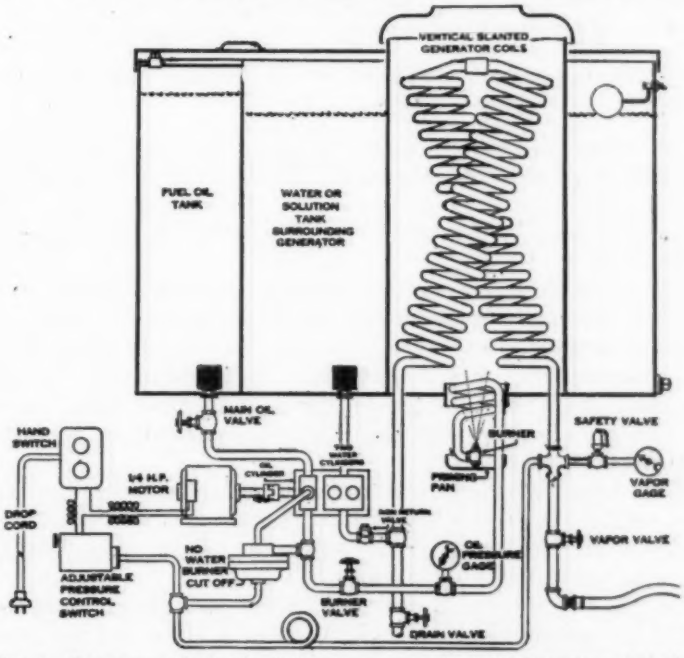

FIG. 2. Diagrammatic sketch of the steam generator indicating the principal parts used in its operation.

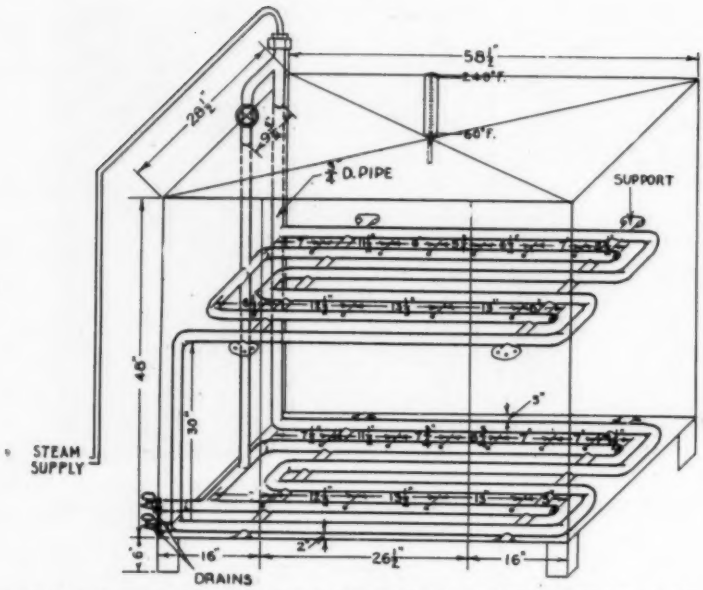

FIG. 3. Diagrammatic sketch of the steam chest indicating the position of the racks and the location of the steam jets in the pipes.

steamed in the same way as the metal containers, except that smaller quantities of sterile water were used in rinsing. Five hundred cubic centimeters were used for quart, 250 cc. for pint and 125 cc. for half pint bottles. The bottles were inverted in the regular milk bottle crates and placed in the steam chest to be sterilized.

The number of bacteria present after steaming was determined by total counts on solid media and the dilution method, employing lactose broth.

Temperature readings were taken during the steaming of the utensils at one minute intervals when the load of utensils in the steam chest had a weight of 225 pounds. The temperature was taken with a tested thermometer located 2 inches from the top of the sterilizing chest and insulated from the metal wall, as shown in Figure 3.

After the completion of the laboratory tests, the steam generator was located on two farms, A and B, both retail milk producers. They continued to use their present equipment, except their steam boilers. Their heating unit was replaced with the described apparatus.

On Farm A, the owner had been using a five H.P. steam boiler which was heated with bituminous coal. The sterilizing apparatus that had been used was a combination brush bottle washer and sterilizer. On this farm approximately 150 quarts of milk were retailed per day.

On Farm B the owner had been using a five H.P. steam boiler, heated with a standard make of fuel oil burner. On this farm a steam chest was used, very similar in design to the one used in the laboratory tests. On this farm, approximately 300 quarts of milk were retailed per day. Steam was used to sterilize equipment three times a day for 20 minutes on farm A, and 30 minutes on farm B, in addition to heating the necessary wash water.

Data on cost of operation was taken for two weeks on each farm, during the months of June and July, 1937.

TABLE 1

Steam sterilization of dairy utensils contaminated with

Time min.	No. of trials	No. bact. per cc. of rinse H_2O before sterilization	No. bact. per cc. of saline solution after sterilization	No. lactose broth tubes showing growth (10 inoculated)
		A		
		Bacillus subtilis		
30	4	845,750	0.5	4
20	3	1,200,000	0.94	5
15	4	2,687,500	0.66	6
10	3	790,000	1.75	7.5
5	2	3,900,000	25.7	10
		B		
		Staphylococcus aureus		
30	4	3,635,000	0.87	1.5
20	3	1,090,000	0.16	2
15	4	1,835,000	1.08	4.25
10	3	2,240,000	2.0	5
5	2	3,650,000	41.7	10
		C		
		Escherichia coli		
30	4	2,035,000	0	0
20	3	5,500,000	0.16	0.2
15	4	3,875,000	0.29	1.5
10	3	3,000,000	1.25	4.5
5	2	4,100,000	23.8	10

RESULTS

It is apparent from the data that this type of steam generator is efficient in generating steam for the destruction of bacteria upon dairy utensils. Table 1 shows the results of steaming metal utensils that had been contaminated with milk cultures of *Escherichia coli*, *Staphylococcus aureus*, or *Bacillus subtilis*. Table 2 shows the results of steaming similarly contaminated milk bottles. The data in the two cases are much alike.

The results indicate that a 15-minute treatment under the given load is sufficient to render the utensils practically free from bacteria. Longer periods of steaming do not appear to have any advantage in the sterilizing operation. Passon (4) found that "if the steam is evenly distributed in the cabinet, and

TABLE 2

Steam sterilization of milk bottles contaminated with

Time Min.	No. of Trials	Quarts			Pints			Half Pints		
		No. Bact. per cc. of rinse H_2O before sterilization	No. Bact. per cc. of saline sol. after sterilization	No. Lactose broth tubes showing growth (5 inoculated)	No. Bact. per cc. of rinse H_2O before sterilization	No. Bact. per cc. of saline sol. after sterilization	No. Lactose broth tubes showing growth (5 inoculated)	No. Bact. per cc. of rinse H_2O before sterilization	No. Bact. per cc. of saline sol. after sterilization	No. Lactose broth tubes showing growth (5 inoculated)
					A					
					Bacillus subtilis					
20	3	2,200,000	.16	2.5	2,150,000	.33	2.5	2,200,000	.5	1.5
15	3	2,750,000	1.0	1.5	1,500,000	.83	5	580,000	.5	2.5
10	3	3,700,000	1.16	4.5	2,600,000	.55	4	5,350,000	.5	5
5	2	2,850,000	37.5	5	2,850,000	26.5	5	2,100,000	40.0	5
					B					
					Staphylococcus aureus					
20	3	12,500,000	.16	.5	1,650,000	0	0	1,800,000	.16	.5
15	3	260,000	.16	0	3,950,000	.8	2.5	4,200,000	.50	1.0
10	3	750,000	.85	1.5	850,000	0	0	370,000	0	0
5	2	2,800,000	72.0	5	1,500,000	84.5	5	2,150,000	130	5
					C					
					Escherichia coli					
20	3	1,050,000	0	0	1,700,000	.5	.5	4,200,000	.16	1
15	3	1,250,000	0	0	7,850,000	1.15	1.5	5,750,000	.5	.5
10	3	3,000,000	0	0	2,300,000	0	0	1,700,000	.66	0
5	2	9,200,000	20.5	5	8,900,000	33.5	5	100,000	32.0	4.5

it is ascertained from a reliable thermometer placed in the top of it that a temperature of 200° F. or over has been maintained for 5 minutes or more, it is certain that practical sterilization of utensils has been obtained.''

The data show that with both metal containers and bottles, the least heat-resistant organism, *Escherichia coli* (Tables 1C, and 2C) is killed in the 10 minute period of treatment. In the case of the more heat resistant type, *Staphylococcus aureus* (Tables 1B, and 2B), the 15 minute treatment is significantly better than the 10 minute. With the most heat-resistant, spore forming type, *Bacillus subtilis* (Table 1A, 2A), the results are inconsistent, even in the longer periods of treatment. Nicholas, Sperry and Tomey (3) found that the temperature of the utensils for the destruction of *Bacillus subtilis* is 325° F.

Figure 4 shows the range of temperature in the steam chest during various

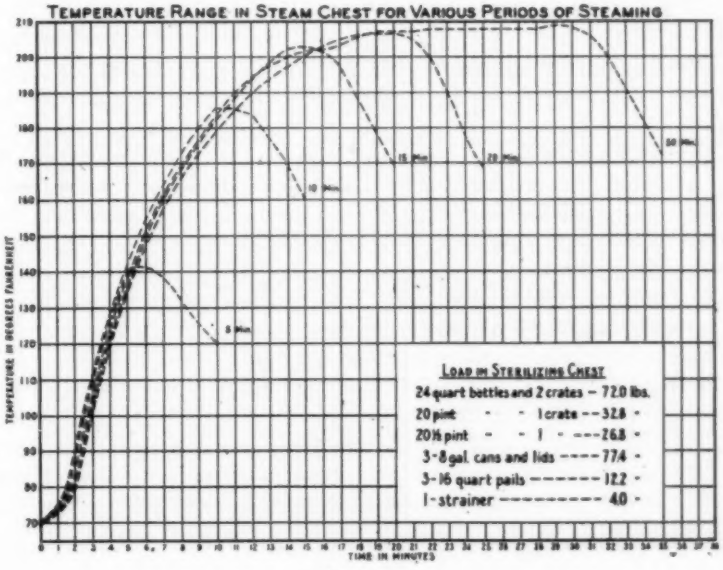
TEMPERATURE RANGE IN STEAM CHEST FOR VARIOUS PERIODS OF STEAMING
TEMPERATURE IN DEGREES FAHRENHEIT
TIME IN MINUTES
LOAD IN STERILIZING CHEST
24 quart bottles and 2 crates – 72.0 lbs.
20 pint - - 1 crate - - 32.8 -
20½ pint - - 1 - - - 26.8 -
3-8 gal. cans and lids - - - - 77.4 -
3-16 quart pails - - - - - - 12.2 -
1-strainer - - - - - - - - - 4.0 -

FIG. 4.

lengths of steaming when the total weight of the load to be sterilized was 225 pounds. These temperatures were taken with a tested thermometer located at the top of the sterilizer. Farrell (1) found the temperature variation within a steam cabinet is not very great and that the temperature of the utensils follows very closely the temperature of the sterilizer.

The curves show that the temperature in the steam chest rises rapidly when the steam is first turned on, and that the rate of heating decreases as the temperature approaches the maximum of 212° F. The temperature also falls

TABLE 3

Data on sterilization of dairy equipment, including bottles, milking machines, cans, pails, and strainer

	FARM A			*FARM B*	
	Size, 150 qts. per day			Size, 300 qts. per day Steam chest—5′ × 6′ × 3′	
	Hypressure JENNY	Oil steam boiler	Coal steam boiler	Hypressure JENNY	Oil steam boiler
Time required to obtain steam pressure	3–5 min.	40–60 min.	60–90 min.	3–5 min.	40–60 min.
Steam pressure carried	75#	40–50#	40–50#	75#	50#
Fuel oil used (2 weeks)	38 gal.	66 gal.		70 gal.	165 gal.
Coal			¾ ton		
Cost of fuel (2 weeks)	$2.85	$4.95	$3.36	$5.25	$12.37
Size of boiler	Equiv. 5 H.P.	5 H.P.	5 H.P.	Equiv. 5 H.P.	5 H.P.
Time required to reach 180° F. in steam chest	(no steam chest used)			15 min.	15 min.

more rapidly during the first part of the cooling, with the exception of the first minute, in which there is very little change in temperature. The rate of cooling decreases as the temperature approaches that of the room.

The utensils were dry when removed from the steam chest, providing they were not removed immediately after the steam was turned off and the steam pressure was maintained in the closed pipes for 5 minutes to serve as a drier.

The machine was found simple and convenient to operate. It was put into operation by pressing an electric switch, and lighting the burner. From this time on it operated independently. If the steam was turned off the automatic switch stopped the machine at the set pressure, and as soon as the valve was opened, operation was automatically resumed.

In Table 3 are shown the data on the sterilization of dairy equipment in farms A and B, where the apparatus was used under actual operating conditions. Under these conditions, the apparatus was compared with the oil steam boiler and the coal steam boiler and data obtained on the time required to obtain steam pressure, steam pressure carried, size of the boiler, time required to reach 180° F. in the steam chest and the comparative costs.

CONCLUSIONS

An instantaneous steam generator is especially advantageous when steam is needed frequently for short periods of time.

The advantages of the described instantaneous steam generator to generate steam for the sterilization of milk utensils and bottles as shown in this experiment are as follows:

1. It generates sufficient steam to render the utensils practically free from bacteria in 15 minutes of operation.
2. It requires only 3 to 5 minutes to generate steam pressure of 75 pounds.

3. It is small and more compact than the steam boiler.

4. It requires a minimum amount of labor to operate.

5. The apparatus is easy to operate; it starts by pushing an electric switch and lighting the burner and runs independently after setting the pressure.

6. It produces a minimum amount of dust, dirt, and odors.

7. It is comparatively economical to operate, costing less than an oil steam burner and slightly less than a coal steam boiler.

8. Utensils can be dried without removing them from the steam chest.

9. It is possible to combine chemical cleaners with the steam in one operation.

10. Hot water for washing can be provided by injecting steam, produced by this generator, into the water line.

This apparatus has the following disadvantages:

1. It does not provide for heating the milk house during the winter months except by the use of radiators.

2. It has a considerable number of moving parts to wear and to be greased.

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SOME PROPERTIES OF MILK POWDERS WITH PARTICULAR REFERENCE TO SWEET BUTTERMILK POWDERS

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Dried milk is a product of modern invention. The production of skim milk powder has grown from nothing in 1900 to over 300,000,000 pounds in 1937, while the production of dried buttermilk was about one-third of a million pounds in 1916 and over 50,000,000 in 1937. The large production and consumption of milk powders has given rise to a large number of problems relative to storage, keeping qualities, flavor control and the like.

REVIEW OF LITERATURE

Factors Affecting the Keeping Qualities of Milk Powder

The keeping quality of a food product has a direct bearing on its market value. Considerable difficulty has been experienced in keeping dried milk in good condition until it is consumed.

Palmer and Dahle (1) have suggested that the presence of air within the granules of spray process powders influences materially oxidative deterioration of whole milk powders made by this process.

Dahle and Palmer (2) later report powders exposed to moist air exhibit poor keeping qualities and give oxidation of the fat as the cause of deterioration. Time, temperature and type of container were found to influence keeping quality.

Holm, Greenbank and Deysher (3) found that precondensation and homogenization of milk improves the keeping quality of the resultant powder and conclude that the improvement is probably due to removal of the volatile oxidative catalysts by heat in the treatment. They also report progessively poorer keeping qualities with increased fat content.

Holm, Greenbank and Deysher (4) later report results indicating that clarification of milk preferably as soon as possible after drawing and high pasteurization temperatures, but not excessive ones, are conducive to good keeping qualities in the resultant powder.

Holm, Wright and Greenbank (5) report that keeping quality is largely dependent upon the inherent quality of the fat of milk powders. Their results also indicate that free moisture has a decidedly retarding effect upon susceptibility to oxidation. It was found that clarification improves the inherent quality of the fat.

Dahle and Palmer (6) find that factors known to favor oxidation proved detrimental to peroxidase activity.

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Palmer, Dahle and Macy (7) conclude that oxidative and hydrolytic decomposition and destruction of the peroxidase are accelerated by increasing the moisture content of the powders.

Supplee (8) states that staleness, decreased solubility and discoloring are more likely to occur in skimmilk than in whole milk powder, and attributes it to excessive moisture content. He found that with increased fat content there was improvement in keeping quality. This is contradictory to the results of Holm, Greenbank and Deysher.

Holm and Greenbank (9) found that the presence of water under certain conditions will retard oxidation and aids in preventing the formation of a tallowy odor. Acidity it was concluded plays a greater part in oxidation than any other one factor. Processes which remove acid therefore improve keeping qualities.

Supplee and Bellis (10) state that the development of insolubility of proteins in milk powder is due to the presence of moisture. Moisture free air was found to have no effect on solubility. Insolubility increased with increase of moisture content of powders.

Supplee (11) reports that with slow circulation of air with a relative humidity of 75 to 80 per cent through partially skimmed milk powder rapidly increased the moisture content of the powder and decreased its solubility. At moisture levels below 3 to 3½ per cent the protein of milk powder was found to remain soluble after one year.

EXPERIMENTAL

Twenty samples of various kinds of milk powders were obtained through courtesy of the Milk Producers Association of Modesto, California, and the Land O'Lakes Creamery Association. Acidity, moisture, solubility and fat determinations were made on each of these samples and an accurate record was kept of the method of manufacture and the kind of each powder. Varying percentages of sulphuric acid solutions were used to obtain a range of vapor pressure corresponding to relative humidities of 40, 60, 80, and 100 per cent. Samples representing one gram dry weight of each of the different types of powder were then placed in humidors having the above mentioned relative humidities.

Weights were taken, in most instances, daily for five days with a chemical balance, and the rate of moisture absorption determined. After the first five days weights were taken only every five days until thirty days had elapsed.

After samples were thought to have reached moisture equilibrium, those in humidors having 40 per cent relative humidities were placed in humidities of 80 per cent and then the humidity was again lowered to 40 per cent. In the case of those placed in 60 per cent relative humidity, the relative humidity was raised to 80 per cent and then lowered to 60 per cent. Dehydration studies were made on these samples. To study the effect of heat treatment

on hygroscopic properties, four samples were dried by holding them in a 25-inch vacuum at 100 degrees C. for four hours. Four other samples were dried by holding them in vacuum oven for four hours at 65 degrees C. These samples were then given the same treatment as the undried samples.

The "Marquardt Method" was used in all the solubility determinations. Solubility determinations were made on samples which had been stored in various types of containers in a refrigerator and in a store room. Solubility of the fresh samples was also determined. A detailed description of the temperature of storage and the types of containers is given later. These samples were also examined for keeping qualities.

RESULTS

Hygroscopic Properties

There was a tendency for samples to reach moisture equilibrium after about 20 days. In 40 per cent relative humidity the average moisture content of all samples was 7.15 per cent, at 60 per cent relative humidity after 20 days 11.30 per cent, and after 20 days at 80 per cent relative humidity the average moisture content of all samples was 19.15 per cent. Drum dryer powders had more original moisture than did spray process powders but absorbed only about one-half as much moisture as did spray process powders at 40 per cent relative humidity. The moisture content of drum dryer powders at equilibrium was usually a little higher than that of spray process powders, however. This greater absorption of moisture by spray powders may have been due in part to the average lower fat content of the samples manufactured by the spray process. Powder made from sour buttermilk or neutralized buttermilk absorbed more moisture than sweet buttermilk powder. Skimmilk powder absorbed less moisture than either sweet or sour buttermilk powders.

A study of the effect of heat treatment of samples on their hygroscopic properties showed that dehydrated samples in general have a lower moisture equilibria at all vapor pressures tried than do undehydrated samples. Samples which were dehydrated by holding them in vacuo at 65 degrees C. reached a slightly higher moisture equilibria at 40 per cent relative humidity than did samples dehydrated by holding in vacuo at 100 degrees C. for 4 hours. The average moisture content after 40 days in a 40 per cent relative humidity of samples dried in vacuo at 65 degrees C. was 7.43 per cent, for samples held in vacuo at 100 degrees C., 6.74 per cent. At 60 per cent and 80 per cent relative humidity, the reverse was true. The samples dried in vacuo at 100 degrees C. absorbing slightly more moisture than did the samples dried at 65 degrees C. The process of heating the sample in dehydrating is thought to be the important factor in lowering its water absorbing powers and probably also accounts for the smaller amount of water absorbed by Drum dryer powders than by spray powders.

A study of the hydration-dehydration rates of both dehydrated and undehydrated samples showed the same tendencies for both types of samples. When samples were dehydrated from 40 per cent to 80 per cent relative humidity and then dehydrated back to 40 per cent, they tended to retain more moisture than they had previous to hydration. The average difference for 8 samples was 1.22 per cent. In hydrating from 60 per cent to 80 per cent relative humidity and then dehydrating back to 60 per cent, the reverse of the above situation was true. After dehydrating back to 60 per cent relative humidity the eight samples had a moisture retention average of .165 per cent less than they had previous to hydration-dehydration. The difference, however, is insignificant.

Hydration curves were much more irregular than were dehydration curves. There was a tendency for all samples to absorb moisture rapidly for the first four or five days of hydration after which time the samples lost a small amount of moisture over a period of 15 to 20 days at which time equilibrium was reached. In dehydrating, the moisture was dissipated very rapidly for the first 24 hours after which time the loss was very gradual for about 20 days at which time moisture equilibrium was reached.

A comparison of the heat treated and un-heat treated samples showed that the equilibria points for the maximum water retention by the two kinds

TABLE 1

Moisture absorbed by various samples at the several relative humidities

Sample No.	Kind of powder	Moisture content when equilibria was reached			Acidity	Fat	Method of manufacturing
		40 per cent	60 per cent	80 per cent			
		%	%	%	%	%	
1	Sweet buttermilk	7.15	11.35	19.75	0.18	8.4	Drum dryer
2	"	7.00	11.05	19.75	0.18	8.2	" "
3	"	7.00	10.90	19.70	0.18	8.4	" "
4	"	7.15	9.40	19.55	0.18	8.2	" "
5	"	7.80	11.60	22.05	0.19	5.85	Spray
6	"	8.65	10.15	19.20	0.18	5.75	"
7	"	8.10	11.95	18.25	0.15	5.25	"
8	"	7.41	10.06	18.30	.....	5.75	"
9	"	7.87	9.93	18.66	.....	5.60	"
10	"	6.45	9.26	21.00	0.12	5.52	"
11	"	6.55	9.25	20.42	0.13	4.80	"
12	Sour buttermilk	6.65	8.00	23.10	0.65	7.05	"
13	"	5.15	6.50	27.00	0.65	7.05	"
14	"	7.32	11.83	23.88	0.80	6.99	"
15	"	7.07	11.52	23.60	0.70	5.95	"
16	"	6.79	8.68	22.88	0.47	5.39	"
17	"	6.12	8.65	21.90	0.47	4.96	"
18	Skimmilk	7.00	8.20	17.65	0.18	0.95	"
19	"	7.20	8.30	17.65	0.18	1.15	"
20	"	7.35	10.60	17.85	0.18	1.15	Drum dryer

of samples are very near the same. However, when these samples were placed in lower humidities, the samples which had been previously heat treated or dehydrated, lost more water than those samples which had not been so treated.

The per cent of moisture taken up and retained by milk powders varies inversely as the per cent of fat. This was observed to be especially true in higher humidities.

Since fat materially affects the moisture equilibria of milk powders, a study was made of the moisture absorbed on the basis of the fat free solids of various kinds of powders.

As was to be expected, the fat free solids of drum dryer process powders were shown to absorb less moisture than did the fat free solids of spray powders when the powders tested had not been dehydrated in vacuo. When samples which had been heat treated were tested the reverse of the above situation occurred. The fat free solids of the dried spray powders absorbed less moisture than did the fat free solids of the drum dryer powders. This would indicate that the heat treatment affects the moisture absorbing properties of the spray process powders more than is the case with the drum dryer powders.

A summary of the effect of various properties of milk powders on their moisture absorbing ability is shown in Table 1.

Solubility

Table 2 shows the effect of storage on the solubility of five different milk powders, 1 A, 1 B, 1 C, 1 D, and 1 E in different containers and at different temperatures. All these powders were over 99 per cent soluble when fresh except 1 E which had a solubility of 97.5 per cent.

It seems that neutralization of sour milk increases the solubility of the resultant powder when fresh, although it dissolves considerably slower than powder made from sweet milk.

Storing in a refrigerator, at 35 to 50 degrees F. in three different containers, had very little effect on solubility of powders 1 A, 1 B, and 1 D, except the sample of 1 D which was stored in a "Sealrite" pasteboard carton and showed a solubility of 94 per cent.

There was considerable reduction in the solubility of powders 1 C and 1 E made from neutralized milk. The samples stored in containers admitting air showed the lowest solubility.

There was a very material decrease in the solubility of all the powders stored at room temperature, the greatest reduction, however, being in the powders made from neutralized milk and stored in containers admitting air. All powders, stored in a desiccator at room temperature in "Sealrite" pasteboard containers, and in open crucibles, possessed practically the same solubility after one year of storage as the fresh powder, except sample 1 C which

TABLE 2

Moisture content and solubility of buttermilk powders when fresh and after storage for one year at room temperature, and in refrigerator at temperature 35–50 degrees F.

Sample number	Container	Per cent of moisture after one year's storage				Solubility after one year's storage			
		When fresh	Refrigerator	Store room	Store room in desiccator	When fresh	Refrigerator	Store room	Store room in desiccator
1 A	Carton	5.37	8.65	6.1	3.95	.998	.988	.957	.994
	Sealed bottle		7.2	6.6			.977	.734	
	Cork-stoppered bottle		7.0	6.8			.991	.730	
	Crucible								.986
1 B	Carton	7.26	9.7	6.0	4.25	.995	.992	.691	.994
	Sealed bottle		6.8	7.0			.992	.674	
	Cork-stoppered bottle		7.0	5.7			.991	.694	
	Crucible								.989
1 C	Carton	8.55	10.7	6.7	5.5	.991	.624	.594	.954
	Sealed bottle		7.2	7.6			.939	.642	
	Cork-stoppered bottle		7.6	7.6			.952	.624	
	Crucible								.937
1 D	Carton	6.24	10.5	6.4	3.5	.997	.940	.928	.996
	Sealed bottle		5.2	5.4			.981	.978	
	Cork-stoppered bottle		5.4	5.6			.989	.978	
	Crucible								.996
1 E	Carton	8.58	11.5	7.5	5.4	.975	.654	.675	.973
	Sealed bottle		5.3	5.9			.955	.952	
	Cork-stoppered bottle		6.0	6.4			.958	.951	
	Crucible								.975

showed a solubility of 95.4 and 93.7 as compared to a solubility of 99.1 for the fresh powder.

A study of Table 2 would indicate that storage temperature very materially affects the solubility of the powder. Although all the powders made from sweet milk contained a high moisture content they retained high solubility when stored in a refrigerator at 35 to 50 degrees F.

Table 3 shows the moisture content of seven different powders, the solubility of these powders at two different periods, and the solubility after exposure to an atmosphere of 40 per cent relative humidity for 90 days, and after exposure to an atmosphere of 70 per cent relative humidity for 30 days.

TABLE 3

Solubility of buttermilk powders before and after being held in atmosphere of 40 per cent and 70 per cent relative humidity

Sample No.	Moisture	Solubility		Exposed to 40 per cent relative humidity for 90 days	Exposed to 70 per cent relative humidity for 30 days
		Date 2–15–28	Date 6–18–28		
1	4.27	99.5	98.0	87.2	59.0
2	4.15	99.8	99.7	91.3	54.2
3	4.38	99.7	99.8	92.4	52.4
4	4.32	99.8	99.8	93.7	55.9
5	4.30	99.5	99.5	96.8	58.3
6*	5.61	73.0	64.2	79.6	59.5
7*	5.44	95.6	79.6	78.9	58.4

* Samples 6 and 7 were made from sour buttermilk.

All the powders showed a big reduction in solubility after being exposed to 70 per cent relative humidity and all of them except No. 6, showed a lower solubility after being exposed to 40 per cent relative humidity, than they did previous to this exposure. The solubility of No. 7 made from neutralized cream was only slightly lower after exposure to 40 per cent relative humidity.

No. 6 was made from sour unneutralized milk and showed a higher solubility after being exposed for 90 days to 40 per cent relative humidity than it did at either of the two previous tests.

This would indicate that exposing powders made from sour milk to an atmosphere of relatively low humidity increases their solubility. The result of one sample, of course, is not sufficient to warrant any conclusions.

The temperature during the time of exposure of powder to 40 per cent relative humidity ranged from 60 to 80 degrees F. while the temperature during exposure to 70 per cent relative humidity ranged from 75 to 85 degrees F.

Keeping Qualities

Tables 4 and 5 show the effect of storing in different containers and at

different temperatures on color and flavor of powders 1 A, 1 B, 1 C, 1 D, and 1 E.

TABLE 4

Change in color of buttermilk powders stored for one year in different containers and at different temperatures

Sample No.	Container	Color		
		Room temperature	Refrigerator 35°–50° F.	Room temperature in desiccator
1 A	Sealrite Carton	Discolored		
	Sealed glass stoppered bottle	Discolored		
	Cork stoppered bottle	Discolored		
1 B	Sealrite Carton	Discolored	Slightly discolored	
	Sealed glass stoppered bottle	Discolored		
	Cork stoppered bottle	Discolored		
1 C*	Sealrite Carton	Highly discolored	Discolored	Discolored
	Sealed glass stoppered bottle	Highly discolored	Slightly discolored	
	Cork stoppered bottle	Highly discolored	Slightly discolored	
1 D	Sealrite Carton	Slightly discolored	Slightly discolored	
	Sealed glass stoppered bottle			
	Cork stoppered bottle			
1 E*	Sealrite Carton	Highly discolored	Discolored	
	Sealed glass stoppered bottle	Slightly discolored		
	Cork stoppered bottle	Slightly discolored		

* Samples 1 C and 1 E were made from sour buttermilk.

Practically all of the samples stored at room temperature became discolored but samples 1 C and 1 E made from neutralized buttermilk contained considerably more color than the samples made from sweet buttermilk.

Samples 1 C and 1 E stored at room temperature become very yellow in color in the different containers, namely, "Sealrite" pasteboard containers, glass stoppered bottles sealed with paraffin, and cork stoppered bottles unsealed; while those powders stored in the refrigerator at 35 to 50 degrees F. were either uncolored or very slightly discolored, with the exception of 1 C stored in a "Sealrite" container.

Only powders 1 C and 1 E showed any material discoloration after being stored in refrigerator in "Sealrite" containers at 35 to 50 degrees F. None

TABLE 5

Flavor of buttermilk powders stored for one year in different containers and at different temperatures. Flavor score 10 perfect

Sample No.	Room temperature		Refrigerator temperature 35°–50° F.		Room temperature in desiccator	
1 A	Stale, musty, slightly tallowy	5½	Slightly stale	8	Slightly musty	7
	Stale, slightly fruity	5½	Slightly stale	9		
	Slightly musty, stale, slightly rubbery	5*	Stale, musty, rubbery	6*		
1 B	Slightly stale, slightly musty	6	Very slightly stale	9	Slightly fruity	7
	Slightly tallowy, slightly stale	5½	Good	10		
	Tallowy, musty, slightly bitter	5	Musty, stale	6½		
1 C**	Acid, coarse, bitter, soapy	5	Sharp, bitter, soapy, coarse, musty	5	Acid, coarse, very bitter, musty	4
	Acid, very bitter, soapy, coarse	4½	Sour, bitter, soapy, coarse, slightly stale	5		
	Acid, bitter, soapy, coarse, musty	3½	Acid, bitter, soapy, sharp, musty	5		
1 D	Stale slightly musty, very slightly tallowy	5	Slightly old, slightly stale	7	Slightly fruity slightly musty	6½
	Tallowy, stale	5	Very slightly stale, very slightly musty	7		
	Tallowy, stale	5	Slightly musty, slightly stale	7		
1 E**	Acid, stale, bitter	5	Sour, bitter, sharp, slightly musty, slightly soapy	4	Acid, bitter, cheesy, musty	3½
	Fruity, acid, bitter cheesy, musty, slightly putrid	2½	Cheesy, rubbery, acid, bitter	2½		
	Acid, bitter, cheesy, soapy	2½	Acid, cheesy, bitter, soapy	3		

* Containers had rubber stoppers.
** Samples 1 C and 1 E were made from sour buttermilk.

of the powders stored in a desiccator at room temperature in "Sealrite" containers showed any discoloration, except 1 C.

It would seem that discoloration in milk powders is a result of high temperature, moisture, and air, and powders made from sour or neutralized milk are prone to discoloration in storage.

The scores and criticism of the powders are given in Table 5. The scoring was made on the basis of 10 for the best sample. The scores were so uniformly low that it is difficult to make any suggestions except that the samples stored in refrigerator were on an average higher than those stored at room temperature. The scores of the sweet buttermilk powders averaged higher than those of the powders made from neutralized buttermilk.

Value of Sweet Buttermilk Powder as a Substitute for Gelatin

To determine the gel value of sweet buttermilk powder in ice cream five different mixes were prepared with the following composition:

38 % ..... total solids
15 % ..... sugar
12 % ..... fat
10.5% ..... serum solids
0.5% ..... gelatin in mixes containing gelatin

All mixes were pasteurized at 145 degrees F. for 30 minutes and homogenized at 2000 pounds pressure. The mixes were so planned as to have one mix with sweet buttermilk powder and gelatin, one with sweet buttermilk powder without gelatin, one mix with condensed skimmilk and gelatin, one mix with condensed skimmilk without gelatin, one mix with skimmilk powder without gelatin.

After freezing and hardening, one pint of the ice cream, from each mix which had been held 24 hours in cartons at about zero F., was placed on a wire gauze over a beaker at a room temperature of 78 degrees F. and the time noted required for the ice cream to melt. The conditions and appearance of the different samples on melting were also noted.

This experiment was repeated the second time.

The results of this experiment indicated that sweet buttermilk powder did not have any value as a substitute for gelatin in ice cream making.

SUMMARY AND CONCLUSIONS

1. To possess good keeping quality milk powder must be low in moisture.
2. Moisture absorption proceeds at a rapid rate at first but it required considerable time before equilibria is reached.
3. Drum dryer process powders absorb less moisture than do powders produced by the spray process.
4. The amount of moisture absorbed by powders varies indirectly as the fat content.
5. Skim milk powder absorbs less moisture than sweet buttermilk powder.
6. In an atmosphere of 100 per cent relative humidity sweet buttermilk powder may contain as much as 50 per cent moisture while powder made from sour buttermilk may contain as much as 75 per cent.
7. Moisture equilibria levels before hydration to a higher level are lower than after dehydration from these higher levels back to the lower.
8. The heating of milk powders to high temperatures in vacuo lowers their moisture equilibria levels and also limits the effect of the phenomenon observed in No. 7 to a narrow margin.
9. Sweet buttermilk powders made by the spray process are practically all dispersible, over 99 per cent, in water at 135 degrees F.

10. The development of small amounts of acid in buttermilk lowers the dispersibility of the resultant powder.

11. Buttermilk powders stored in refrigerator at 35 to 50 degrees F. had a higher dispersibility after being stored for one year than powders stored at room temperature.

12. High storage temperatures (70 to 90 degrees F.) encourage discoloration in buttermilk powders.

13. Powders made from sour buttermilk possess very poor keeping qualities and are prone to discoloration in storage.

14. Sweet buttermilk powder made by the spray process retained its original dispersibility for three years in a desiccator containing calcium chloride.

15. Sweet buttermilk powder does not possess any gel value in ice cream.

16. Sour buttermilk powder will retain more moisture than sweeet buttermilk powder when placed in desiccator containing calcium chloride.

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CONTROLLING MILK PASTEURIZATION EFFICIENCY THROUGH THE USE OF THE PHOSPHATASE TEST*

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The application of heat to milk for the purpose of destroying all pathogenic bacteria and to reduce appreciably the number of those organisms that cause spoilage and off-flavor development has become a standard practice in the dairy industry. So much emphasis has been placed upon the need of proper pasteurization in order to safeguard the health of the consumer of dairy products that it is extremely important that health officials and plant technicians be equipped with some method for accurately determining the efficiency of pasteurization.

It might be supposed that with our present system of pasteurization, there would be little occasion for errors in the process itself. However, there are instances in which inaccurate thermometers, leaky valves, and the human element have resulted in incomplete pasteurization. The industry is confronted, therefore, with the problem of securing an accurate test that will detect such discrepancies in the milk pasteurization process.

It is not too difficult to establish a series of characteristic requirements for such a test. Within all limits of practicability the test should have the following features:

1. Sufficiently accurate to detect cases where milk has not been held the required period of time nor at the required temperature.
2. Sufficiently accurate to detect even minute contamination with raw milk.
3. Rapidly performed.
4. Simple; *i.e.*, not require an elaborate layout in the way of equipment or chemicals, nor an unusual amount of skill on the part of the operator.

Kay and Graham's (1) method for determining the efficiency of pasteurization, based on the thermo-stability of the enzyme phosphatase contained in milk comes nearer to meeting the above requirements than any test previously developed. Several modifications of this test have been developed recently, which tend to increase its sensitivity and accuracy.

The object of this study was to determine the effectiveness and accuracy of the phosphatase test when applied to milk, and also to develop an accurate method for determining color intensities.

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EXPERIMENTAL PROCEDURE

Scharer's (2) modification of the original Kay and Graham test was used to determine the phosphatase content. This test is dependent upon the amount of phenol liberated by the action of the phosphatase enzyme on an excess of di-sodium phenyl phosphate during an incubation period of one hour at 37.5° C. The amount of phenol liberated is determined colorimetrically, by comparing with known phenol standards.

Photoelectric Procedure

After attempting to determine, by use of various colorimeters, the intensity of color of the phenol solutions, it was decided to attempt to develop a method which would not be dependent upon the use of the human eye to differentiate between various color intensities. A photoelectric procedure was developed which made possible the accurate determination of the amount of phenol present.

The photoelectric cell has been used extensively in various types of industrial and commercial research because of the accuracy of results obtainable. The principle of the photoelectric cell is based upon the fact that certain metals, such as sodium and potassium, have the property of giving off electrons when they are exposed to ordinary light. A photoelectric tube may be constructed by coating a portion of the inside of an evacuated glass bulb with metallic sodium or potassium. This forms one terminal of the circuit. The other terminal is a metallic electrode placed inside the bulb near the coated surface. When light falls upon the metallic coating, electrons pass to the other terminal and a flow of current results, the strength of the current depending upon the amount of light the metallic coating receives. When no light strikes the metallic coating the current ceases.

In order to select the type of photoelectric cell to be used in this procedure, it was necessary to determine the spectrum range of the solutions to be studied. Using a spectrophotometer the spectrum range of a series of phenol standards was determined. This range was found to be between 5000 and 7000 Ångstrom Units. The photoelectric cell selected as a result of this test was a Visitron F_2 showing great sensitivity in this range. Unlike various other forms of photoelectric cells, the Visitron F_2 operates without an external voltage and is intended primarily to be used without vacuum tube amplification. When light impinges upon the metallic surface, an electric current is set up producing its own E.M.F. at the terminals of the cell which causes the current to flow through an external circuit.

To further sensitize the system a glass filter with a sharp cut-off at 7000 Å was placed in front of the photoelectric cell. This glass filter allows only light of the wave length between 5000 and 7000 Å to pass on the surface of the cell.

In order to eliminate fluctuations of voltage from the line to the light source, a voltage regulator was connected between these two points. This eliminated any possible experimental error due to variations in the intensity of light passing through the colored solutions being measured in the course of the experiment.

The electrical hookup for a photoelectric cell is shown in Figure 1.

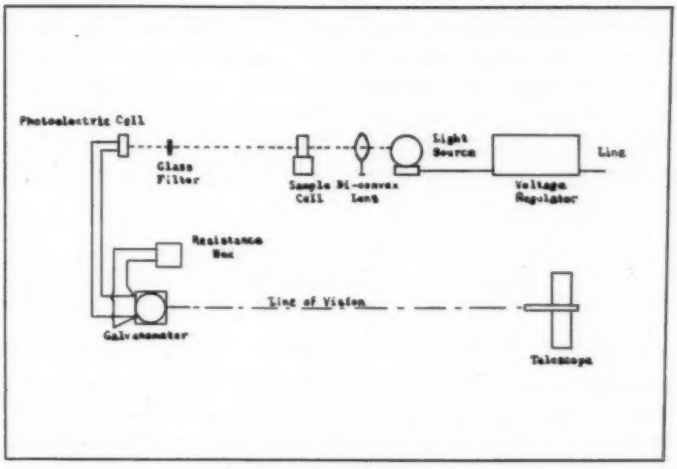

FIG. 1. Photoelectric unit.

Apparatus

1. Photoelectric Cell—Visitron Type F_2.
   G. M. Laboratories, Inc., Chicago, Illinois.
2. Glass Filter—Square Polished—No. 348. Y–4, 3½ in.
   Corning Glass Works, Corning, New York.
3. Glass Sample Cell—consisting of two parallel-planed Pyrex glass windows with a capacity of approximately 10 ml.
4. A 100-Watt, 115-Volt Lamp.
5. Voltage Regulator-Type VR3.
   Ritter Sales Co., Chicago, Illinois.
6. Galvanometer—Leeds and Northrup—Equipped with a special sensitive suspension.
7. Resistance Box—Leeds and Northrup Adjustable—10,000 ohms.

All apparatus was mounted on a stationary table on a floor free from vibrations.

Method of Measuring Intensities of Colored Solutions

In using the adjustable resistance box it was possible to obtain any desired deflection on the galvanometer. Due to this fact it was necessary to establish one or more standard deflections of the galvanometer which could

be used every time a test was run. The method of obtaining these standard deflections was as follows:

The glass sample cell was thoroughly cleaned and rinsed with distilled water. The outer parts were dried with a soft cloth and the cell filled with 6 ml. of double-distilled water. This water was made up in a 500 ml. portion and stored at 50° F. The sample cell was placed in the holder provided for in the set-up of the equipment. The zero point on the galvanometer was adjusted. The shade was then removed from the light source which allowed the light to pass through the sample cell. The deflection of the galvanometer was adjusted using the resistance box. The water solution was removed from the cell and in its place was added a standard phenol solution which had been stored one hour at 50° F. The deflection of this solution was then determined and the per cent deflection calculated according to the following formula:

$$\frac{\text{Deflection of water solution—Deflection of unknown solution}}{\text{Deflection of water solution}} = \text{Per cent Deflection of unknown solution}$$

Determining Per Cent Deflection of the Standard Phenol Solutions

Standard phenol solutions (0.5 to 10 ppm.) were prepared and the color intensity of these solutions determined using the photoelectric cell. Using water deflections of 25, 30, and 35 cm., the per cent deflections of the phenol standard solutions were calculated. All solutions were prepared in triplicate. The results are given in Table 1.

TABLE 1

Color intensity of standard phenol solutions in per cent deflection

Phenol in ppm.	Percent deflection 25 cm.*	30 cm.*	35 cm.*
0.50	24.20%	22.60%	22.50%
1.00	38.00	35.22	35.27
1.50	48.10	46.68	45.37
2.00	58.80	58.07	58.07
3.00	69.60	68.08	67.50
4.00	78.10	77.40	77.36
5.00	80.40	81.20	82.60
10.00	85.80	85.90	86.31

* Deflection of water solution.

As a result of this procedure a value of 35.00 cm. was selected as the standard deflection of the water solution. This value was set as the maximum and if the equipment could not be adjusted to obtain this value, then a value below 35 and above 30 was used, since the percentage deflection of the phenol standard solutions was approximately the same at these two values. Throughout the experiments conducted it was found that the deflection of

the water solution could be adjusted at all times within one cm. of the value 35 cm.

The values of percentage deflection obtained using a water deflection of 35 cm. were plotted as shown in Figure 2. These values were placed on the ordinate and the corresponding phenol values on the abscissa.

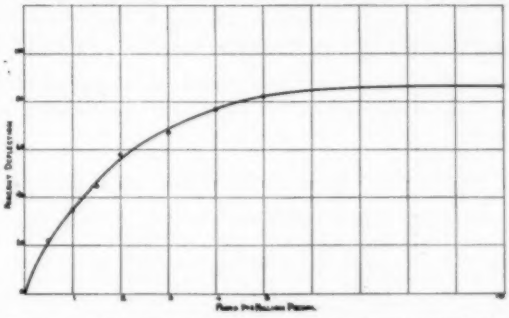

FIG. 2. Photo-cell calibration curve of phenol standards.

TABLE 2

Conversion table for phenol values

Deflection percentage	ppm. Phenol	ppm. Phenol per 1% deflection	Deflection percentage	ppm. Phenol	ppm. Phenol per 1% deflection
5.00	0.100		47.50	1.500	
		0.0200			0.0572
10.00	.200		50.00	1.643	
		0.0220			0.0868
15.00	.310		52.50	1.860	
		0.0260			0.0232
17.50	.375		55.00	1.928	
		0.0248			0.0720
20.00	.437		57.50	2.108	
		0.0252			0.0620
22.50	.500		60.00	2.263	
		0.0280			0.0624
25.00	.570		62.50	2.419	
		0.0372			0.0900
27.50	.663		65.00	2.654	
		0.0372			0.0790
30.00	.756		67.50	2.852	
		0.0448			0.0992
32.50	.868		70.00	3.100	
		0.0348			0.0950
35.00	.955		72.50	3.348	
		0.0428			0.1240
37.50	1.062		75.00	3.658	
		0.0400			0.1368
40.00	1.160		77.50	4.000	
		0.0420			0.1360
42.50	1.265		80.00	4.340	
		0.0400			0.1984
45.00	1.364		82.50	4.836	
		0.0544			0.3698

Using Figure 2, Table 2 was constructed showing the percentage deflection in one column, the corresponding parts per million of phenol in the other, and in the third column the value in parts per million of phenol for each per cent in deflection between two consecutive deflection values. Using Table 2 it is possible to calculate the color intensities of any phenol solution if the percentage deflection is known.

APPLICATION OF THE PHOSPHATASE TEST TO MILK

A study was made to determine the accuracy of the phosphatase test when applied to milk. The milk used in the following experiments was collected from a mixed herd.

Determining the Effect of Heat on the Phosphatase Content of Milk

In this experiment four lots of milk were heated to the following temperatures and held for 30 minutes: 142, 143, 144, and 145° F.

Samples were taken at the end of 15, 20, 25, and 30 minutes and immediately cooled in an ice water bath to prevent further enzyme inactivation. The phenol values obtained are given in Table 3.

TABLE 3

*Time and temperature of pasteurization as related to phenol value**

Holding period	Temperature of pasteurization			
	142° F.	143° F.	144° F.	145° F.
	Parts per million phenol			
15 minutes	3.05	2.40	1.65	0.88
20 "	1.90	1.47	0.80	0.70
25 "	1.36	1.06	0.75	0.62
30 "	1.04	0.80	0.60	0.50

* Phenol value of raw milk—5.75 p.p.m.

These data are of particular interest from the standpoint of the relative effect of the different pasteurizing temperatures at different time intervals. It is apparent from the data that variations of one degree Fahrenheit or five minutes in the holding period are detectable; however such discrepancies would be more difficult to detect at 145° F. than at 142° F. Values in parts per million of phenol obtained at the end of 30 minutes may be established as the pasteurization value of milk at each of the above temperatures; any value in excess of the above would be indicative of incomplete pasteurization. Slight discrepancies, however, could not be conclusively detected without access to the original milk in the raw state which could be pasteurized and used as a reference sample.

Effect of Contamination of Pasteurized Milk with Raw Milk

A series of experiments were performed to determine to what extent the

presence of raw milk in pasteurized milk could be detected. The pasteurized samples were heated to 144° F. for 30 minutes. Typical results are given in Table 4.

TABLE 4

Detection of contamination of pasteurized milk with raw milk

Percentage raw milk	Parts per million phenol
100.00	8.80
1.00	1.80
0.50	1.20
0.40	1.08
0.30	0.94
0.20	0.81
0.10	0.69
0.00	0.60

It is evident that the addition of as much as 0.1 per cent raw milk to a pasteurized sample can be detected. It would, however, be difficult to detect this without the use of a photoelectric cell, as 0.09 parts per million of phenol difference cannot be detected by the naked eye. Addition of 0.2 or 0.3 per cent, however, may be detected without the use of the photoelectric cell.

Effect of Homogenization on the Phosphatase Enzyme

Ten gallon samples of raw milk were homogenized at two different temperatures and at various pressures. The milk was immediately homogenized after being heated, and the homogenized samples obtained immediately cooled in an ice water bath. Phenol values are given in Table 5.

TABLE 5

Effect of homogenization on the phenol value

Pressure	Temperature of homogenization	
	90° F.	143° F.
	Parts per million phenol	
No pressure	2.85	2.95
1000 pounds	2.88	2.95
1500 "	2.86	2.93
2000 "	2.86	2.77
2500 "	2.84	2.46

It is evident from these data that homogenization by pressure has no effect on the phosphatase enzyme. Although there is a small decrease in the phenol value of the sample homogenized at 143° F., this may be attributed to the fact that there was a lapse of approximately 5 minutes between the 1000 pound pressure sample and that of 2500 pounds. This 5 minute period corresponds to a 5 minute period during pasteurization and a decrease in the phosphatase activity would be expected. Several degrees rise in tempera-

ture during the homogenization process might be another contributing factor to this decrease in phosphatase activity.

Effect of Preservatives

There would be a distinct advantage in adding preservatives to the milk samples which are to be examined for the efficiency of pasteurization. In this way field samples could be sent to a control laboratory for testing, without danger of spoiling. To check the effect of preservatives on the accuracy of the phosphatase test, samples were prepared as follows:

1. Mercuric chloride—1 tablet to ½ pint of milk.
2. Sodium salicylate—1 gram to ½ pint of milk.
3. Borax—2 grams to ½ pint of milk.
4. Hydrogen peroxide—2 cc. to ½ pint of milk.
5. Formalin—2 cc. to ½ pint of milk.

The samples were run in duplicate and held at room temperature (70° to 80° F.) for a period of three days. At the end of of this time it was noticed that the fat had gathered in a semi-solid mass at the top of the bottle. This condition was least noticeable in the bottle containing hydrogen peroxide. The bottles were shaken vigorously and a sample taken from each for the phosphatase test. The bottles were then placed in a hot water bath and heated to 100° F. to melt the fat, after which additional samples were taken. The average of triplicate tests on duplicate samples is given in Table 6.

TABLE 6

Relation of the presence of preservatives to the accuracy of the phosphatase test

Preservative added	Before heating	After heating to 100° F.
	Parts per million phenol	
None	0.66	0.66
Mercuric chloride	0.67	0.67
Sodium salicylate	0.92	0.91
Borax	0.70	0.70
Hydrogen peroxide	0.87	0.86
Formalin	0.60	0.59

Another test was run to determine whether the temperature of storage of the preserved samples would affect the phosphatase test. One set of the following samples was stored at a temperature of (70 to 80° F.) and another set of the same samples was stored at a temperature of (45 to 50° F.), for a period of three days.

1. Mercuric chloride—1 tablet to ½ pint of milk.
2. Sodium salicylate—2 grams to ½ pint of milk.
3. Borax—2 grams to ½ pint of milk.
4. Hydrogen peroxide—2 cc. to ½ pint of milk.
5. Formalin—2 cc. to ½ pint of milk.

The average of triplicate tests on duplicate samples is given in Table 7.

TABLE 7

Relation of storage temperature of preserved samples to the accuracy of the phosphatase test

Preservative added	Stored at 70 to 80° F.	Stored at 45 to 50° F.
	Parts per million phenol	
None		0.70
Mercuric chloride	0.70	0.69
Sodium salicylate	1.20	1.16
Borax	0.73	0.71
Hydrogen peroxide	0.83	0.81
Formalin	0.66	0.61

The results of these two experiments indicate, that of the preservatives studied, only mercuric chloride could be used as a preservative of milk without affecting the accuracy of the phosphatase test, as it consistently gave the same phenol value as that of the control sample.

Heating the preserved samples to 100° F. for the purpose of remixing the separated fat does not alter the value of the test.

Storing the preserved samples at temperatures of (45 to 50° F.) or (70 to 80° F.) had no appreciable effect on the results obtained. Although there was a consistent decrease in the phenol value of the samples stored at the lower temperatures, this variation ranges from 0.01 to 0.05 parts per million phenol and is negligible.

SUMMARY

1. Variations of one degree Fahrenheit or 5 minutes in the holding period were detected using the phosphatase test.

2. The addition of 0.10 per cent raw milk to a pasteurized sample was detected.

3. Homogenization by pressure had no effect on the phosphatase enzyme.

4. Mercuric chloride was used as a preservative of milk without affecting the accuracy of the phosphatase test. Heating the preserved sample to 100° F. to remix the separated fat had no effect on the value of the test. Storing preserved samples of milk at temperatures of (45 to 50° F.) or (70 to 80° F.) had no effect on the results of the test.

CONCLUSIONS

The results obtained in this study indicate that, within certain limits, the Scharer Test can be applied as a check on the efficiency of the pasteurization process.

No attempt was made to modify Scharer's procedure, except that a photoelectric method was developed which proved to be a great aid in obtaining definite values for the color intensities of the phenol solutions.

The need for improvement in the phosphatase test, both in method and interpretation of results is apparent, since no definite conclusions can be drawn on any sample of milk without knowledge of the temperature at which that milk has been pasteurized. There is especially a need for standardizing the method if it is to be used for condemning or accepting pasteurized milk. It is possible that, in order to make the test strictly reliable, one standard for both time and temperature of pasteurization of milk will need to be adopted.

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THE OCCURRENCE OF STREPTOCOCCUS ZYMOGENES IN THE INTESTINES OF ANIMALS

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Division of Dairy Industry, University of California, Davis, California

Among the hemolytic streptococci which are encountered in the control of milk supplies are the so-called hemolytic enterococci, specifically *Streptococcus zymogenes* and *Streptococcus durans*. Because of their greater heat tolerance, these types are especially apt to be isolated from pasteurized milk in which other kinds of hemolytic streptococci are seldom found (3). The hemolytic enterococci occur rather abundantly in the intestines of normal human beings (6), and their occurrence in the intestines of other warm-blooded animals is a natural presumption. However, from the standpoint of any possible sanitary significance in milk, it is important to know definitely whether or not such hemolytic streptococci do normally occur in the intestines of animals, especially the cow.

The present work was undertaken in an effort to determine if hemolytic streptococci of the *Streptococcus zymogenes* or *Streptococcus durans* types may be present in the feces of the cow and the horse. The object was simply to answer this somewhat significant question; no effort was made to get quantitative data concerning the numbers of these organisms present, nor concerning the proportion of animals which harbor them.

Isolations were made from fresh samples of feces by two methods: One part of the sample was plated directly in poured blood agar, using several dilutions. A second portion was placed in 1 per cent sodium carbonate (7), held 24 hours at laboratory temperature, and plated in various dilutions in blood agar. Only colonies which gave broad zones of hemolysis in the blood agar were isolated for further study.

In the case of horse feces, *Streptococcus zymogenes* was isolated from one of the first three samples examined, and hence the search was carried no further. The isolation of hemolytic streptococci from cow feces proved more difficult, probably because of the occurrence in much larger numbers of the non-hemolytic *Streptococcus bovis* and *Streptococcus fecalis*, which are hardy organisms and not easily inhibited by selective procedures. However, *Streptococcus zymogenes* was obtained from one out of twenty samples of cow feces examined.

The cultures of *Streptococcus zymogenes* isolated were studied by means of all of the physiological tests which have been used for the description of this organism (4) (5) (6) and were found to be typical. They were also subjected to a serological study and found to belong to the Lancefield (1)

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group D, which group is known to include *Streptococcus zymogenes* (5) and, apparently, all of the other well-recognized types of enterococci (2).

This brief study is sufficient to show that *Streptococcus zymogenes* occurs, not infrequently, in the intestinal tracts of domestic animals. It is entirely possible that this organism is abundant in the feces of cows, but its isolation from this source is fraught with technical difficulties. Since *Streptococcus zymogenes* occurs in the bovine intestine, and since it is an extremely viable organism which can endure for long periods outside of its natural habitat, it is to be expected that it will occasionally find its way, indirectly, into milk. Its mere presence in milk in small numbers cannot, therefore, be looked upon as having a sinister sanitary significance.

SUMMARY

Streptococcus zymogenes, the most common hemolytic streptococcus in the human intestine, was isolated from the feces of the horse and the cow. The fact that this organism appears to be a normal inhabitant of the bovine intestine is of interest in connection with its occasional occurrence in milk.

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THEOPHILUS LEVI HAECKER
1846–1938

T. W. GULLICKSON
Division of Dairy Husbandry, University of Minnesota

Theophilus Levi Haecker, known as the "Father of Dairying in Minnesota," died at St. Paul, Minnesota, on August 12, 1938, at the age of 92 years. He was buried at Hampton, Iowa.

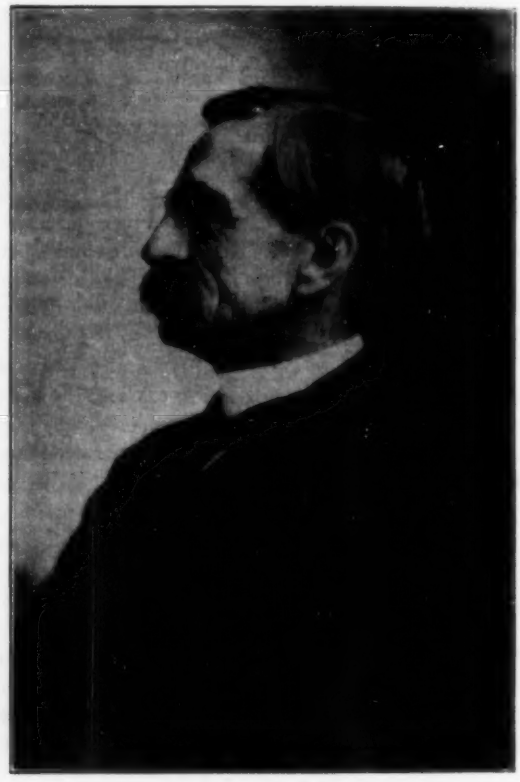
It was in the fall of 1891 that Professor Haecker at the age of 45 years came to Minnesota to begin his memorable and remarkable career as a dairy investigator and leader. His work was particularly noticeable because it was so much broader in its scope than that of a mere scientist absorbed in the intricacies of technical research. His accomplishments were so varied and his personality so human that his right to fame might rest secure on any one of his many achievements. In its effect on the dairy industry his scientific achievements may well be compared with that of the Babcock test for, like it, his discoveries in animal nutrition did away with old guess work methods. Add to this his organization work and the leadership which made Minnesota famous for its cooperative creameries and the leading butter producing state in the Union. These two, representative of his wide field of efforts, so different in character, reflect the versatile qualities of the man. The one required the studious concentration of the scientist—the other the dynamic qualities of the diplomat and salesman. In each it can be said he achieved a lasting success.

While Professor Haecker began somewhat late in life the work which was to bring him fame, yet a perspective view of his early life clearly shows that his whole previous training had really been pointed toward some such goal. He was born of German immigrant parents in a log cabin in Medina County, Ohio, on May 4, 1846. In the autumn of 1853 the Haecker family moved to a farm near Cottage Grove, Dane County, Wisconsin.

Here he attended school in a deserted lob cabin. Speaking of these early days years later, Professor Haecker said: "Most of my work was doing chores and working in the garden and helping with the housework. Mother was an expert buttermaker, and her butter was always spoken for by the year by the best customers in Madison at highest prices. She was my teacher not only in dairy manufacture but in production. Under her direction we gradually built up quite a nice dairy. Mother was superlatively orderly, neat, and industrious, and having spent so much of my younger days with her I received a training which was helpful in my personal experience in dairying."

In the autumn of 1863 he entered the University of Wisconsin, and the following March he enlisted as a drummer in the 37th Wisconsin Volunteer Infantry. After the war he went to Hampton, Iowa, where his parents

had moved. Following this, he worked as a farm hand, ran a threshing outfit, attended the University of Wisconsin, taught school, published a newspaper and finally returned to Cottage Grove, Wisconsin, where he acquired what later came to be known as the Silver Springs dairy farm.



THEOPHILUS LEVI HAECKER
1846–1938

On May 11, 1874, he became a clerk in the office of Governor William R. Taylor at Madison, a position he retained for 17 years. During these years he continued to manage and develop his Silver Springs farm which soon became a veritable experiment station. He also maintained an active interest in the movement for practical agricultural education and helped to put such men as Dean W. A. Henry and Dr. Stephen M. Babcock in charge of this work at the University of Wisconsin.

At the close of Governor Hoard's administration, Mr. Haecker left the state capitol but soon thereafter enrolled at the University of Wisconsin for the first session of the dairy school—the first of its kind in the world.

Within a week he was made an instructor and put in charge of the home dairy work. Such, then, had been the training and preparation of Professor Haecker up to the time when, in June, 1891, on the recommendation of Dean Henry he was appointed by the Board of Regents of the University of Minnesota an assistant in agriculture in charge of the dairy experiments.

Professor Haecker took up his duties at University Farm, St. Paul, on October 1, 1891. From the day of his arrival until his retirement 27 years later, he devoted all his physical and mental energy to the development and advancement of dairying in Minnesota and the world. During this time he dealt with practically every phase of the industry, from the care and feeding of the herd to the manufacture and sale of the finished product. In all his research work, it was characteristic that he went to the cow herself to learn from her the secrets relating to milk production.

In the winter of 1894–95 he started the very extensive investigation which culminated in the well-known feeding standard which bears his name, the first standard of its kind to recognize that the nutrient requirement of a cow is affected not only by the quantity of milk produced but also by the percentage of fat and other solids present. This principle has since been adopted in all recognized feeding standards. The Haecker feeding standard ranks with the Babcock test in its influence on the dairy industry. This work placed Professor Haecker in the front rank of great scientists. During the last few years before his retirement, Professor Haecker devoted considerable attention to working out a similar standard for beef cattle.

During the first few years after his arrival in Minnesota, Professor Haecker spent much of his time traveling about, getting acquainted with the dairy situation in the state. One day he happened to visit a local cooperative creamery owned and operated by a colony of Danish immigrants at Clarks Grove in Freeborn County. He was greatly impressed by their success. Characteristically, he first made a careful study of the plan and organization of the creamery to determine its soundness and practicability and then took steps to vigorously promote the idea of cooperative creameries to the dairy farmers of the state.

Professor Haecker was especially apt in his ability to disseminate information whether to farmer or to student. He was in great demand as a speaker and traveled widely over the state speaking at fairs, farmers' institutes, dairy conventions and similar meetings. For many years he edited the dairy column for Farm, Stock, and Home and was a frequent contributor to Hoard's Dairyman. It has been said that he exerted an influence second to none upon the dairy industry.

He also possessed exceptional foresight and judgment and coupled with these gifts, his sincerity and common sense enabled him to assume the leadership not only among his colleagues but also of the dairy farmers of the northwest. Indeed, Minnesota's present eminence in butter production rather than in cheese is largely attributable to his vision and leadership. Recog-

nizing the necessity of producing butter of high quality if it were to compete successfully in the markets of the country, he inaugurated short courses in buttermaking for creamery operators in which the means and methods of making high quality butter were taught. A total of about 2500 buttermakers were trained in this school by Professor Haecker.

Professor Haecker was regarded by most of his students as an inspiring teacher; to others, however, he appeared a severe taskmaster—a veritable tyrant. This, however, was only because he had no patience with indolence and slipshod methods—a heritage from his early training. Recently in speaking about this characteristic, he said, "I knew what I wanted and I had the courage to stand by until I got it. Whatever I did, I did well." To Professor Haecker the dairy cow was the most wonderful animal in the world, "God's gift to mankind." Again and again he admonished his classes, "Treat the cow kindly, boys. Remember she is a lady—and a mother." Again speaking about the cow, he said: "Surely the ways of the cow are very strange. She does and she doesn't, and then again she does neither."

Professor Haecker lived to see his early hopes and efforts come to their full fruition, a privilege accorded to but very few. During his life he was the recipient of many honors. Many dairy organizations tendered him testimonials of appreciation of his leadership and of their indebtedness to him. Undoubtedly the most prized of these was the one presented by Land O'Lakes Creameries, Inc., in June, 1935, on the occasion of the annual meeting of the American Dairy Science Association, held at University Farm, St. Paul. In 1909 he was a delegate to the international dairy convention at Budapest. The University of Wisconsin in 1923 honored him as a national leader in the fields of cooperative dairying and cattle feeding, and in 1929 he was selected by a leading dairy journal as one of the ten scientists of the world who had contributed most to the advancement of the dairy industry. In 1925, the new dairy building of the University of Minnesota was dedicated as Haecker Hall. Inside on one of its walls is a bronze plaque which bears a striking medallion portrait of Professor Haecker and with it the following tribute to him:

In Honor of
Theophilus Levi Haecker
In Charge of Teaching and
Research in Dairy Husbandry
University of Minnesota
1891–1918
For his Investigations in the
Nutrition of Dairy Cattle
And his Leadership in Organizing Co-operative Dairying
The Nation is his Debtor

American Dairy Science Association Announcements

THIRTY–FOURTH ANNUAL MEETING, PULLMAN, WASHINGTON, AND MOSCOW, IDAHO, JUNE 26–30, 1939

The Program Committee for the annual meeting is anxious to have an indication of the probable attendance. The November number of the Journal carried railroad and Pullman car rates from Chicago, Columbus, Washington and New York. If you are planning to go by rail, have you informed the Secretary of the type of transportation desired by you? Many of the members are planning to travel by automobile making the trip a vacation for the family. The Program Committee has a few touring kits left containing road maps and other travel information of interest. You are welcome to them until the supply is exhausted. By all means plan to attend this year's meeting for a glorious trip to the progressive and scenic Pacific Northwest with its Grand Coulee Dam, its beautiful lakes and streams, cool nights and hospitable people.

CALL FOR TITLES AND ABSTRACTS OF PAPERS

It has been decided to publish the abstracts of papers, to be presented at our annual meeting, in the June number of the JOURNAL OF DAIRY SCIENCE and to issue this number a little earlier than usual in order to have it in the hands of the members before leaving for the meetings at Pullman, Washington, and Moscow, Idaho. Consequently it will be necessary for us to have all abstracts in our hands by April 15. Please send titles and abstracts to Vice-Dean E. V. Ellington, Department of Dairy Husbandry, State College, of Washington, Pullman, Washington.

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ABSTRACTS OF LITERATURE

BOOK NOTICE

Elements of Dairying. T. M. Olson. 570 pp., illustrated, price $3.50. The Macmillan Co., New York.

Elements of Dairying is a survey of the Dairy Industry intended for use as a textbook in the first course in dairying. It is divided into six parts under the headings, "The Dairy Industry," "Dairy Cattle," "Milk," "The Processing Industries," "Feeding Dairy Cattle," and "Dairy Herd Management."

This book "intended to be used as an introduction and not as an exhaustive treatment" should experience enthusiastic acceptance. It covers a field in which the number of available texts have been quite limited in recent years. In addition to serving as a text for the first course it should be equally valuable for groups of students who take only one course in dairying, for example students majoring in Agricultural Education or Agricultural Extension.

This work is well illustrated and well written. Many of the more recent developments in the dairy industry are presented. A unique feature in the appendix is a history and informative discussion of each of the national dairy organizations.

G.W.B.

BACTERIOLOGY

56. The Respiration of the Rod-Shaped Lactic Acid Bacteria. P. A. Hansen. Zentralbl. f. Bakt. *98:* 289–297, 1938.

Twelve representative strains of lactobacilli (Thermobacteria, Streptobacteria and Betabacteria) and microbacteria served for an inquiry of the respiratory mechanism. All experiments were carried out in a Srensen Phosphate buffer solution with the Warburg respiration apparatus. Results in brief:

Qo_2 of glucose varies from 1 (*Thermobacterium cereale* and *helveticum*) to 124 (*Microbacterium flavum*). *Thermobacterium* and *Streptobacterium* have no hemin in contradistinction to *Microbacterium.*

It is recommended to consult quantitative respiration experiments for taxonomic purposes. K.J.D.

57. Contributions to the Knowledge of the Reduction of Cow's Milk with Reference to the Reduction Mechanism. H. O. Jensen. Zentralbl. f. Bakt. II, *96:* 234–257, 1937.

Reduction of methylene blue in *pure cultures* of lactic acid streptococci, micrococci and sporeformers is strongest, but more cells are needed in raw

milk to get the same effect. Alkali formers show a very slow reduction. The reduction power ceases in general as the cells grow older (retarding effect of lactic acid).

Reduction of methylene blue in *raw milk:* The most active reducing germs are the lactic acid streptococci; *B. coli* and micrococci, however, exert practically no influence. The bactericidal power does not materially retard the decoloration of the dye.

The reduction is intensively connected with the energy metabolism of the cell and the author discusses the relation of it to the theory of dehydrogenation of Wieland.

The reductase test is only useful for certain limited purposes, besides that it must be combined with other tests. K.J.D.

58. Dye Concentration in Culture Media Employed for the Analysis of Escherichia-Aerobacter Members in Milk. HERBERT D. MCAULIFFE and M. A. FARRELL, Div. of Bacteriology, Pennsylvania State College, State College, Pa. Am. Jour. Pub. Health. *28:* 10, 1217, 1938.

The concentration of the bacteriostatic agents in fuchsin lactose broth and in brilliant green lactose bile broth 2.0 per cent was developed for use in water analysis. Addition of 1 ml. portions of milk to these media adsorbed a considerable amount of the dyes present, thereby lessening the selective action of these media in the detection of the *Escherichia-Aerobacter* group of organisms in milk.

The authors determined the concentration of the free dye present after adsorption and found that the content of basic fuchsin in fuchsin lactose broth should be increased from 1 part in 66,666 to 1 part in 9,500, and the content of brilliant green dye in brilliant green lactose bile broth 2.0 per cent increased from 1 part in 75,188 to 1 part in 30,000. With these modifications, false presumptive tests were largely eliminated without lessening the selective properties of these media for the *Escherichia-Aerobacter* group. M.W.Y.

BREEDING

59. Midget Cows. GERALD BENEDICT. Nat. Butter and Cheese Jour. *29:* 21, 27, 1938.

Otto Gray, Stillwater, Oklahoma, has developed a strain of midget cows ranging in height from thirty inches to thirty-seven inches. Leg length is twelve inches. The midget weighs four hundred to five hundred pounds and produces from thirty-five to forty-one pounds of milk per day. Forty-one pounds of this milk produced two and one-thirds pounds of butter. W.V.P.

CHEESE

60. Bacteriological and Chemical Examinations of Normally and Badly Ripened Tilsit Cheese. W. MEYER. Zentralbl. f. Bakt. II, *98:* 212–232, 1938.

The *normally* ripened Tilsit cheeses of different make did not show very many discrepancies regarding the microflora: After a primary acceleration of the growth of the streptococci the streptobacteria were developing and did not decrease until after the second month. The streptobacteria have a significant proteolytic power, but this is variable with the different strains. Their microscopic appearance in cheese is streptococcus-like. The thermobacteria do not develop earlier than 5–6 weeks after fabrication and decrease again after the 8th week. The acidoproteolytic cocci were always abundant and play an important rôle in Tilsit cheese ripening. The water soluble and amino-N proved to increase slowly, but constantly during ripening. Cheeses, made from highly buffered milk (addition of resp. salts), showed a materially different microflora as compared with normal cheeses. The lactic acid bacteria and acidoproteolytic cocci were after 2–3 weeks substituted by a flora, which mainly consisted of putrefactive germs and sporeformers. Many other bacteria could be found, which never were detected in normal cheeses. The reaction of the curd changed to the alkali range. The aroma was sweetish-putrefactive and partially bitter. The water soluble N did not show any significant difference in comparison with the normal cheese, but the value of amino-N was much higher with the poor cheeses. K.J.D.

61. Propionibacterium rubrum from Dairy Cheese. M. LUBOW. Zentralbl. f. Bakt. II, *99:* 107–115, 1938.

The organism was isolated from rusty spots in cheese. The morphological and physiological characters were those of van Niels *Propionibacterium rubrum* (raffinose and mannitol +). The relation of propionic acid to acetic acid was higher than 2:1. The pigment formation proved to be independent from oxygen. The red dye was very stable and it could not be destroyed by the common special agents, either by hydrochloric, sulfuric or nitric acid. K.J.D.

62. Pasteurization of Milk for Cheese Making. (In two parts.) W. V. PRICE, Univ. of Wis., Madison, Wis. Nat. Butter and Cheese Jour. *29:* 21, 16, 1938; *29:* 22, 20, 1938.

The commercial application of pasteurization of milk for the manufacture of cheese is discussed. A partial review of the literature includes fifty-seven references. It is indicated that pasteurization of milk for cheese is applicable to the most important types manufactured in the United States

excepting Swiss. Pasteurization improves the quality of cheese by eliminating defects caused by undesirable organisms in the raw milk. It improves the uniformity and keeping quality of the cheese and may be regarded as a necessity when conditions beyond the control of the cheese maker endanger the quality or healthfulness of the factory milk supply. W.V.P.

63. Buys Milk by Grade. PAUL H. MANDT, Milwaukee, Wis. Nat. Butter and Cheese Jour. *29:* 23, 6, 1938.

The Outagamie Producers'-Consumers' Cooperative, Black Creek, Wisconsin, grades milk for cheese making by taste, smell, sediment, methylene blue and curd test, and places second grade milk in a vat by itself. This milk is made into cheese and producers who furnish the "B" milk are paid for it only what the cheese is worth. The differential in price ranges from one to three cents per pound of butterfat. This program has resulted in the production of over ninety-eight per cent of cheese in the State Brand grade. Record sheets are shown for milk grading, operating statements, cost statements, and daily manufacturing records. W.V.P.

64. Purpose and Function of Starters in Cheese Making. H. F. LAABS. Nat. Butter and Cheese Jour. *29:* 21, 28, 1938.

This is a practical discussion of the purposes of using starter and the effects of acid development in cheese making. It is stated that starter inhibits the growth of undesirable bacteria, favors curdling of the milk with rennet, aids in expulsion of whey, favors the fusing of curd particles, aids in the development of cheese flavors and aroma and establishes proper conditions for the mellowing of cheese. W.V.P.

65. Salting American Cheese for Flavor. J. L. SAMMIS, Univ. of Wis., Madison, Wis. Nat. Butter and Cheese Jour. *29:* 22, 6, 1938.

A large proportion of the cheese made today does not contain enough salt to be perceptible to the taste. Makers commonly add two and one-half pounds of salt to one hundred pounds of curd but much of this salt is lost in the brine running from the gate and from the press. The author recommends that this amount of salt is sufficient providing the curd is milled into small pieces and these pieces well stirred to keep them from matting and providing the milled curd pieces are wet with brine. If a pail is placed under the open gate at the time of salting to catch the brine from the curd the brine can be poured over the curd and stirred into it every five or ten minutes for an hour between salting and hooping. More emphasis should be placed upon the salt content of cheese by cheese score cards. W.V.P.

FEEDS AND FEEDING

66. Notiz über den Vitamin-Gehalt der Topinamburknollen. (Note on the Vitamin Content of Jerusalem Artichoke Tubers.) A. SCHEUNERT, Veterinär-Physiologischen Institut der Universität Leipzig. Biedermann's Zentralblatt, Abteilung B. Tierernährung. *10:* 4 & 5, 449–450, 1938.

Trials with tubers of the Jerusalem artichoke (*Helianthus tuberosus*) showed that they contain only very small quantities of vitamins B_1 and C. Therefore they cannot be considered of importance as vitamin carriers for either humans or animals. J.G.A.

67. Die Eigung der Kakaoschalen zur Verfütterung an Milchkühe. (The Suitability of Cocoa (cacao) Shells as a Feed for Milk Cows.) A. HAMBURG RICHARDSEN. Biedermann's Zentralblatt, Abteilung B., Tierernährung *10:* 4 & 5, 443–448, 1938.

Cocoa shells must be regarded as a substitute feed, consisting only of offal, and of foreign origin. It would be unwise to expect too much from this feed. It may be given to older cattle without risk, but it is not to be regarded as a good dairy feed.

Carob-beans proved to be a neutral food. J.G.A.

68. Ein Beitrag zur Futtervolumenfrage bei wachsenden Rindern, gleichzeitig eine studie über die Aufzucht des Rindes. (A Treatise on the Question of Fodder Volume for Growing Cattle, Coincident with a Study in Cattle Raising.) HANS BRÜGGEMANN, Institut für Fütterungstechnik der Versuchs- und Forschungsanstalt für Tierzucht, Kraftborn (Kr. Breslan). Biedermann's Zentralblatt, Abteilung B. Tierernährung. *10:* 4 & 5, 296–384, 1938.

The objective of any feeding standard must be not only the fulfillment of nutrient requirements but the attainment of a state of satiation as well. Satiation is dependent upon the volume of individual feed apportionments.

Although interest in the question of feed volume dates back to the early investigators in animal nutrition, hitherto there has been a divergence of opinion as to methods for ascertaining it. Originally absolute quantity of roughage fed was considered a good measure; later content of dry matter was adopted as a standard, and recently indigestible organic substance ("ballast") has come into use as a criterion of feed volume.

Economic conditions in Germany requiring the extended and increasing use of home-grown roughages, the need for adequate standards respecting feed volume has become more apparent, hence the series of experiments reported here.

Two series of experiments were conducted. The first included several groups of cattle of varying ages during one winter feeding period; in the second series ten heifers were carried through from birth to first calving. All ten were sired by the same bull. In both series feeding was ad libitum, portions unconsumed being weighed back. All feeds were analyzed and the quantities of nutrients consumed were calculated and plotted weekly throughout the duration of the trials.

Results indicated that neither dry matter content nor indigestible organic matter are exact indicators of the volume of any particular ration necessary for satiation, because (1) biological processes of the organism are subject to constant change, and (2) a feeling of satiety is dependent upon somatic stimuli and cannot be judged with absolute objectivity. Differential apportionment of the daily feed allowance gave a better idea of the proper volume of single portions.

Satisfactory growth of the experimental animals, good agreement between individual results and the average, and the fact that the herd at Kraftborn is of well bred black and white lowland stock, warrant the formulation of standards setting forth the proper amounts of feed expressed as single and individual portions for cattle at different stages of growth. These appear in tables and diagrams in the body of the report.

Although the question of feed volume was not solved satisfactorily from a scientific viewpoint, the experiments have demonstrated the soundness of the effort being made in Germany to raise the productivity of cattle by utilization of the resources at hand.

Results of the trials are significantly applicable to practical cattle breeding. Those animals in which there was an especially good development of breadth and depth of the chest, in general showed a high capacity for "ballast" intake and hence for consumption of home grown roughages; further they proved to be especially good feed utilizers.

Attention to these points in selecting animals for breeding would result in an increase in milk yield beyond the present upper limits of production, even if only home grown feeds were fed. J.G.A.

69. Über den Vitamin-A-Gehalt, des Keimöles aus den Samen von Theobroma cacao Linné. (The Vitamin A Content of Germ Oil from the Seed of Theobroma Cacao L.) (The cacao bean.) K. H. WAGNER and L. SEBER. Veterinar-Physiologischen Institut der Universität Leipzig. Biedermann's Zentralblatt, Abteilung B., Tierernährung, *10:* 2 & 3, 261–264, 1938.

Trials with rats receiving either pure B-carotene or cacao bean germ oil, indicate that 100 grams of the oil contained 825–1400 I.U. of vitamin A.

J.G.A.

70. Über den Nährwert des A.I.V.-Futters und dessen Beeinflussung durch die Neutralitätsregulation der gefütterten Tiere. (The Nutritive Value of A.I.V. Silage and Its Influence on Neutrality Regulation in the Animals Fed.) H. Mollgaard and G. Thorbek, Tierphysiologischen Laboratorium der landwirtschaftlichen Versuchsstation Kopenhagen. Biedermann's Zentralblatt, Abteilung B. Tierernährung *10:* 2 & 3, 105–121, 1938.

Dry cows were fed with alfalfa dried either naturally or artificially or ensiled by the A.I.V. process. The silage was fed unneutralized, and neutralized with $CaCO_3$, or with $NaHCO_3$. Mineral balances and respiration trials showed that disturbance of the acid-base balance by the unneutralized silage resulted in a marked increase in heat production. The authors conclude from these results that nutritive value of the silage is directly dependent on neutralization, and that the more complete the neutralization, the higher is the net energy value. As complete neutralization of the fodder as possible is therefore recommended.

Neutralization with alkali carbonates always resulted in a lowering of the digestibility of the feed. When neutralization was effected by the feeding of beets this depressing effect was not in evidence, utilization of the nutrients of the fodder being beyond expectation. J.G.A.

71. Die Bestimmung des allgemeinen Nährwertes (Energiewertes) der Futtermittel nach der chemischen Zusammensetzung. (Estimation of the Energy Value of Feeds from Their Chemical Composition.) J. Axelsson, Institut für Haustier-fütterung der Landw. Hochschule Schwedens Uppsala. Biedermann's Zentralblatt, Abteilung B., Tierernährung. *10:* 2 & 3, 238–248, 1938.

The author proposes to determine energy values of feeds as exactly as possible on the basis of chemical composition. Methods are described for adjusting digestion coefficients and feed unit values. Methods are also proposed for the formulation of a sliding scale of deductions according to the relationships between crude fiber, dry matter, and organic matter content of the feed, and taking into account also feed units as well as starch values. J.G.A.

72. Milchsäure als Sicherungszusatz bei der Gärfutterbereitung. Ein vergleich zwischen normaler Kaltvergärung und der Vergärung bei Zusatz von Milchsäure, Salzsäure, Schwefelsäure, Zucker. (Lactic Acid as a Safety Factor in Silage Preparation. A Comparison between the Ordinary Ensiling Process and Ensiling with Additions of Lactic, Hydrochloric or Sulfuric Acids, or Sugar.) H. Kleinert, Institut für Tierzucht und Milchwirtschaft

an der Universität Leipzig. Biedermann's Zentralblatt. Abteilung B., Tierernährung. *10:* 2 & 3, 122–186, 1938.

Ensiling trials with red clover and alfalfa are described and results noted.

HCl, H_2SO_4, $C_2H_4(OH)COOH$, or sugar added to these protein-rich fodders produced a very good silage. Equivalent quantities of the acids named were about equally efficient for preservation of the fodder. Very fine chopping of the fodder had a very favorable effect.

Conclusions from this and earlier work are:

1. Fodder with ratio between crude protein and N-free extract less than 1:2 (*e.g.*, alfalfa, very young red clover, leguminous mixtures, or young pasture grass) requires 0.4 per cent HCl, or 0.6 per cent H_2SO_4, or 1 per cent of either lactic acid or sugar. A combination of acid and sugar is recommended.

2. Fodder with a crude protein; N-free extract ratio wider than 1:2 (*e.g.*, red clover, Landsberg mixture, sweet lupine, etc.) requires half the above mentioned quantities of the specific preservatives.

Sugar must be diluted with water before adding. Its quantity may be doubled if desired.

Such a silage carefully prepared and fermented below 25° C. (temperature of the mass) will be satisfactory.

In order to have a comparable basis for silages of diverse nature, it is suggested that acidity be expressed in terms of percentage in the dry matter.

J.G.A.

73. Untersuchungen über den Futterwert und die Futterwirkung eines unter Bakterienzusatz eingesäuerten Gemenges aus Erbsen, Wicken und Peluschken im Vergleich zu unbehandeltem Gärfutter gleicher Zusammensetzung. (Studies of the Feeding Value and Effect of a Mixture of Peas, Vetches and "Peluschken" Ensiled with Bacterial Cultures, in Comparison with Ordinary Ensilage of Similar Composition.) K. Richter and J. Herbst, Institut für Fütterungstechnik der Forschungsanstalt für Tierzucht in Kraftborn (Tschechnitz), Kreis Breslan. Biedermann's Zentralblatt, Abteilung B., Tierernährung *10:* 1, 59–67, 1938.

Mixtures of the plants noted were fermented in air-tight receptacles with and without addition of bacterial preparations. Trials with ruminants (wethers) showed a higher digestibility of the N-free extract of the fodder where the bacterial preparation was added. Digestible crude protein and starch value were the same in both kinds of silage.

Later trials with nine milch cows showed that the silage fermented with the bacterial preparation was not superior to the ordinary silage either in its effect on milk yield or production of butter fat, or gain in live weight.

J.G.A.

74. Ten Years of Experimental Results on Cultivated Pastures. T. M. Olson and T. A. Evans. So. Dak. Bull. 324, 1938.

Alfalfa, sweet clover and sudan were used as pastures for dairy cows of quite uniform size and of different breeds.

Observations on bloating were made. Little trouble occurred but when bloating was observed, it took place usually in the evening and only at periods of rapid growth of the pastures.

The palatability of the plants ranked in order were, sudan, alfalfa, and sweet clover. Cows were observed to eat weeds in the sweet clover pasture until accustomed to the clover.

Milk from these cows was unaffected in flavor when they were removed from the pasture 2½ to 3 hours before milking.

Net nutrients per acre showed ranking of the plants in the order, sweet clover, alfalfa, and sudan.

Loss in weight was observed in the cows on sweet clover.

Length of pasture season was about the same for sweet clover and alfalfa but was shorter for sudan. Lack of rain shortened the period for all pastures.

Milk and butterfat produced per acre was as follows:

	Lbs. milk	Lbs. fat
Sweet clover	3668.5	146.68
Alfalfa	3307.9	135.54
Sudan	2766.5	109.95

J.C.M.

75. The Effect of Sunlight on the Growth, Production and Reproduction of Dairy Cattle. T. M. Olson. So. Dak. Bull. 319, 1938.

Two groups of Holstein calves were observed through several generations. One group and their descendants were not exposed to direct sunlight and were called the no-sunlight group. These individuals grew normally, conceived, and reproduced to the fifth generation with no apparent abnormalities. The blood calcium and phosphorus remained normal. The breaking strength of the bones of the sunlight and no-sunlight groups was normal and about the same. They did show inability to withstand the strain of producing milk and maintaining the level of production of the first generation. There was a consistent and marked decline in the butterfat production. They did, however, remain in good physical condition.

Analysis of milk of the two groups showed no significant difference. Milk from the sunlight group when fed to pigs showed it to contain appreciably greater vitamin D potency.

A part of the bulletin includes a study of the effects of winter-produced and summer-produced milkfat. The latter was definitely superior in its effects on the skeletal development of rats. The rats were fed on a rachitogenic ration (Steenbock 2965) and one group received 5 and 10 per cent levels of the milkfat produced as previously indicated. J.C.M.

DISEASES

76. Bovine Tuberculosis in Children. Anonymous. Am. Jour. Pub. Health *28:* 11, 1334, 1938.

A report of work on the subject at the University of Toronto under the National Research Council of Canada is discussed. In a series of 500 tuberculous children, in 9.6 per cent of extrapulmonary tuberculosis, the bovine type was found to be the infecting organism. In every case, it was found that the tuberculous children had been fed raw milk and in three cases the disease was actually traced to the responsible animal. The present report shows that the incidence of bovine tuberculosis in children has fallen from 13.5 per cent in 1935 to 9.6 per cent at present, which is attributed both to the control of cattle tuberculosis in Ontario and to the greater use of pasteurized milk. M.W.Y.

77. Bovine Mastitis the Relation of Streptococci to Physical Changes Occurring in the Udders of Dairy Cows. W. T. Miller and H. W. Johnson, Bur. of Animal Ind., U. S. Dept. of Agr., Beltsville, Md. Am. Jour. Pub. Health *28:* 10, 1222, 1938.

Composite milk samples from 629 cows in 9 dairy herds were examined for the presence of streptococci by the Hotis test, microscopic examination of incubated milk and culture of incubated milk on blood agar plates. Streptococci were detected in 298 milk samples. No streptococcus infected cows were found in 4 herds with a total of 82 animals. Seven groups of streptococci were found of which Group A predominated.

The udders of 617 cows were examined by palpation for indurations. Of the 291 cows infected with streptococci, 2.4 per cent were in Class 1 (free of indurations), while 11.6 per cent of the uninfected cows fell in this group. In Class 2 (slight indurative changes), there were 18.2 per cent of infected cows and 29.4 per cent of uninfected cows. There was no significant difference in Class 3 (definitely indurated) between the two groups, but in Class 4 (marked physical evidence of mastitis) there were 24.7 per cent infected cows against 9.2 per cent uninfected. M.W.Y.

FOOD VALUE OF DAIRY PRODUCTS

78. Nutritional Aspects of Milk. W. E. KRAUSS, Ohio Agr. Exp. Sta., Wooster, Ohio. Jour. Milk Tech., *1:* 3, 22–26, 1938.

In general it is almost impossible to permanently change the chemical composition of milk. The iodine content, however, can be readily changed by varying the cows' intake of this element.

All of the six generally recognized vitamins A, B, C, D, E, and G are found in milk.

Fresh milk is rather a constant source of vitamin B and E, but varies considerably for the others.

Little is known, however, of the vitamin E content of milk other than that 5 per cent of butterfat in the diet will allow normal reproduction in an experimental animal.

Milk is a fair source of vitamin B, but the amount present in milk cannot be increased by feeding methods.

G is abundant in milk, but the amount can be varied by feeding feeds richer in this vitamin. Young grass is apparently a richer source than more mature grass.

Milk varies considerably in vitamin C content. The content is more than it was formally credited with. It cannot be increased measurably by feeding. Breed and stage of lactation are important factors. Of breeds studied, Brown Swiss had highest content and Holsteins lowest. Vitamin C content is highest in fresh milk. High temperature, short-time holding method of pasteurization has little if any effect on it while low temperature long-time holding may be quite destructive.

Milk is a relatively poor source of vitamin D. Highest values in July, August, and September and lowest in February. The content can be increased by feeding.

The vitamin A content of milk is of two forms. The precursor, carotene or colored form, and the true vitamin A or colorless form. The amount of each present depends upon the feed and the breed of the cow. Deeply colored milk from a Guernsey cow would not contain any more vitamin A than the less deeply colored milk from a Holstein cow if both were fed alike. Feed is an important factor. L.H.B.

79. Present Status of Vitamin Milks. E. V. MCCOLLUM, School of Hygiene and Public Health, John Hopkins Univ., Baltimore, Md. Am. Jour. Pub. Health, *28:* 9, 1069, 1938.

The vitaminization of milk with respect to vitamin D is of established value. In the opinion of the author, milk distributors and health officials will do well to delay offering to the public any other kinds of fortified milks than vitamin D milks until the medical profession asks for them.

M.W.Y.

80. Effect of a Milk Supplement on the Physical Status of Institutional Children. 1. Growth in Height and in Weight. LYDIA J. ROBERTS, RUTH BLAIR, BLANCHE LENNING and MARGUERITE SCOTT, Dept. of Home Economics, Univ. of Chicago, Chicago, Ill. Am. Jour. Diseases of Children, *56:* 2, 287, 1938.

The growth of 3 groups of institutional children, consisting of 36 children each, was followed throughout a calendar year. One group remained on the institutional diet as the control; one received daily an additional pint equivalent of evaporated milk and one an equal amount of irradiated evaporated milk.

By all methods of comparison the growth of the children given a supplement exceeded that of the controls. The average excess in mean gain in height was 0.3 inch for both milk groups and in weight was 2.27 pounds for the plain milk and 1.4 pounds for the irradiated milk group.

In the matter of illnesses there was little difference between the three groups and the average number of days for all illness was remarkably alike in the three groups. W.H.R.

81. Effect of a Milk Supplement on the Physical Status of Institutional Children. 2. Ossification of the Bones of the Wrist. VERA MACNAIR and LYDIA J. ROBERTS, Dept. of Home Economics, Univ. of Chicago, Chicago, Ill. Am. Jour. Diseases of Children, *56:* 3, 494, 1938.

Roentgenograms of the wrists and hands of 108 children were taken at the beginning and end of a calendar year, and the progress in osseous development, as indicated by changes in the Carter ossification ratio, was followed. The grouping and dietary regimen of these children have been noted in the preceding abstract.

By all methods of comparison the groups given a supplement (irradiated or non irradiated evaporated milk) showed greater progress than the control group on the rather mediocre institutional diet. The differences were significant and tended in the same direction.

There was no significant difference between the two groups receiving milk. W.H.R.

82. Vitamin A, Carotene and Vitamin C Content of Canned Milk. O. MEULEMANS and J. H. DEHAAS, Dept of Pediatrics, Medical College, Batavia, Netherland East Indies. Am. Jour. Diseases of Children *56:* 1, 14, 1938.

Determinations were made of three to six samples of each variety of imported canned milk obtainable in the retail trade in Batavia. The milk was diluted in the manner indicated on the label as adapted for infant feeding.

Diluted evaporated milk and sterilized whole milk were found to have the same vitamin C content as fresh cow's milk or about one third that of mother's milk.

Milk powder, sweetened canned milk, sweetened skim milk, buttermilk (either powdered or evaporated) and lactic acid milk powder after dilution contain on an average one-half the vitamin C of fresh cow's milk.

Milk powder, sweetened condensed milk, evaporated milk and sterilized milk have a carotene and vitamin A content which lies between that of stall milk and pasture milk in Europe (*i.e.*, from 10 to 25 micrograms and from 20 to 55 International units per 100 cc. of diluted milk).

Sweetened skimmed milk contains practically no vitamin A substances. Evaporated buttermilk and buttermilk powder after dilution contain as few vitamin A substances as fresh buttermilk.

The powder of lactic acid milk contains the amount of carotene and of vitamin A to be found in fresh stall or pasture milk. W.H.R.

83. Your Food and Your Future. E. V. McCollum, Johns Hopkins Univ., Baltimore, Md. Milk Dealer, *28:* 3, 72–74, 1938.

A discussion of food in regard to protein, mineral, and vitamin content. The better sources of these constituents are given and the symptoms produced by their deficiency described. C.J.B.

84. Determination of Ascorbic Acid (Vitamin C) in Milk. O. F. Garrett, New Jersey Agr. Exp. Sta., New Brunswick, N. J. Jour. Milk Tech., *1:* 3, 37–39, 1938.

This is a slight modification of the method proposed by Guthrie and Sharp, of Cornell, and is a practical and usable method intended for use in dairy and commercial laboratories.

Detailed methods for preparing reagents and procedure for making the tests are given. L.H.B.

ICE CREAM

85. The Use of Frozen Condensed Milk in Ice Cream. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *2:* 1938.

(A) H. F. Openlander and J. H. Erb, Ohio State Univ., Columbus, Ohio. p. 35.

The authors conclude that frozen condensed milk, properly frozen and stored is satisfactory for use in ice cream. The storage period studied was up to 13 weeks.

The first noticeable defect which occurred in the ice cream containing thawed frozen condensed skim milk was a curdled melting appearance. Frozen condensed skim milk testing from 27 to 30 per cent total solids was

less prone to produce a curdled melting appearance in ice cream than when the total solids of the condensed product was 40 per cent. The lower and more constant the storage temperature of the frozen condensed skim milk the less trouble was experienced with the melting appearance of the ice cream. Freezing the ice cream containing frozen condensed skim milk on a continuous freezer produced an ice cream slightly more curdy than that frozen on the batch freezer. The use of 0.3 per cent sodium citrate, added to the mix at the pasteurizer corrected the curdy and wheyed off condition which might otherwise result from the use of frozen condensed skim milk in ice cream.

(B) E. L. REITCHART, Univ. of Nebr., Lincoln, Nebr. p. 45.

From his experiments, the author concludes that where skim milk is available at a low cost during the early summer it might well be condensed and placed in frozen storage for later use in ice cream. When the thawed frozen cream was unusually curdy, it was made homogeneous again by homogenization of the melted product. It was found that mixes containing the frozen condensed skim milk differed but little from those made from fresh products. A slight decrease in whipping ability was noted in the mixes containing the frozen products.

In a discussion of this subject following the presentation of the paper, it was stated by the author that the addition of salts to prevent a curdy melting appearance of the finished ice cream was found unnecessary. The suggestion was made from the audience that sweetening the cream before freezing had been found desirable. The author stated that the experiments with frozen condensed skim milk were being continued and the addition of sugar to the product was being studied. M.J.M.

86. Continuous Flow Mix Making. RIDGWAY KENNEDY, JR., Abbotts Dairies, Inc., Philadelphia, Pa. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *2:* 29, 1938.

A description is given of a continuous flow system for handling 2000 gallons of mix per hour. The method was designed to decrease to a minimum the physical effort necessary on the part of the operating crew and to meet all local requirements as to quality control. A diagrammatic flow sheet is given of the machinery and methods used in the mix making operations. M.J.M.

87. The Selection of Butter for Use in Ice Cream. W. B. COMBS, Univ. of Minn., St. Paul, Minn. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *2:* 22, 1938.

The types and grades of butter on the market from which the ice cream manufacturer might make a selection are presented. Data are given to show that the grade of butter used influences the consumers reaction to the finished

ice cream. High scoring sweet cream unsalted butter is recommended as the type and grade best suited for use in ice cream.

Recommendations are made that the ice cream manufacturer should set up definite specifications as to type and grade, pasteurization temperature, sanitary requirements in churning, washing and working, moisture content and keeping quality of the butter he wishes to purchase for use in ice cream.

M.J.M.

88. Selection and Preparation of Fruits and Nuts for Ice Cream. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *2:* October, 1938. (A) **Fruits.** CARL KOERVER, The Borden Co., Brooklyn, N. Y. p. 7.

A fairly complete discussion of the selection of fruits for use in ice cream is summarized by the author as follows:

To produce a strawberry pack of firm texture it is necessary that the fruit be processed immediately after receipt in the plant. The washing has to be done gently, the fruit has to be dried before going into the pack. Enough sugar has to be used to toughen the tissue. The barrels should be rocked, and the cans should be shaken or rotated. The sugar should have a chance to enter the fruit so that it is all melted before the actual freezing sets in and then the freezing should be done as quickly as possible. Based on our experience, a 2 plus 1 pack is recommended.

A properly packed barrel, especially 2 plus 1, should be of the same good quality as tins.

Thawing-out of the fruit at room temperature so that no ice crystals remain, holding slightly above freezing temperature and, when used for injectors, separating the fruit when it is still firm and cold, is absolutely necessary.

The making of a special strawberry mix is advocated to take care of the increase in sugar content due to the higher-sugared strawberries, and also to make the use of plenty of fruit, up to 35 per cent, possible without resulting in too sweet a finished product.

Fruit, such as peaches and pineapple, which are picked in an unripe stage, should be properly ripened before packing.

The use of benzoate of soda as a preservative in any pack should be avoided.

The size of the unit, barrels, half barrels, tins, cans, slabs, should depend on the quantity of fruit used at a time. No open containers should be held but the unit should be emptied.

Utensils for handling the fruit in the ice cream plant should always be washed and sterilized and kept in a clean place.

If these suggestions are followed, fruit ice cream with a clean flavor will result, it will have the same low bacterial count as vanilla ice cream and be negative in B. Coli.

(B) **Nuts.** C. A. IVERSON, Dept. of Dairy Industry Iowa State College, Ames, Iowa. p. 16.

With the advent of buttered pecan a new era in the use of nuts in ice cream began. Experiments have shown that dry roasting of nuts which are then treated with melted butter is a superior method to that of roasting the nuts in butter. A considerable amount of the flavor comes from the butter, which should be heated to about 330° F., then salted. Roughly 4 pounds of nuts is recommended for 10 gallons of finished ice cream.

Suggestions are given for preparing the following kinds of nuts for use in ice cream: Pistachio and Brazil Nuts, Filberts, Cashew Nuts, English Walnuts, Pine Nuts, Butternuts and Peanuts.

Nut meats for use in ice cream must satisfy three conditions. They must impart a distinct and pleasing flavor, must remain crisp and must be tender in the finished ice cream. The author states that it is a question to what extent nuts should be prepared in the ice cream plant for use in flavoring ice cream. He feels, however, that the freshness of the nuts is such an important consideration that some type of nut roasting equipment may be almost as necessary as mixing or freezing equipment. M.J.M.

89. Checking Ice Cream in the Hardening Room and on Trucks. Anonymous. Ice Cream Rev., *22:* 4, 30, 1938.

Accounting forms for a medium sized ice cream company are reproduced that will assist one in getting an accurate check on the ice cream going into the hardening room and that loaded on trucks. J.H.E.

90. Drinking Glass Contamination and Sterilization. RICHARD V. FELLERS, Health Officer, Nutley, N. J. Ice Cream Rev. *22:* 3, 108, 1938.

Results of a survey investigating the bacterial contamination of drinking glasses in restaurants and taverns are given. Conditions surrounding the washing of glasses were found quite unsatisfactory. Large numbers of organisms were found on the glasses of a majority of the establishments. The investigation showed that a sterilizer using sterilamps as the sterilizing agent effectively reduces the bacterial contamination of drinking glasses, and that this form of sterilization is practical and adaptable to general use. J.H.E.

91. Frosted Foods. LUIS GIBSON, Geo. H. Gibson Co., New York City. Ice Cream Rev., *22:* 3, 84, 1938.

Suggestions are given for popularizing frozen foods. Sales can be promoted with a consistent program of skilled store salesmanship, effective store displays, and advertising framed to appeal to the fundamental interests of the housewife. It is suggested that ice cream be sold at frosted foods outlets. J.H.E.

92. An Antioxidant for Dairy Products. C. D. DAHLE, Dairy Dept., Pennsylvania State College, State College, Pa. Ice Cream Trade J., *34:* 12, 16, 1938.

References are made to literature indicating that oatflour may be used to prevent the occurrence of oxidized flavor in potato chips, lard, peanuts, milk, candy, coffee, fish, and fish oils. It has been shown that 0.5 per cent oatflour prevented or delayed the oxidized flavor in strawberry and vanilla ice cream, improved the texture, and made possible a reduction in the amount of gelatine. Two per cent oatflour added to 40 per cent cream after pasteurization delayed oxidation in frozen cream. This product may be added to cream for buttermaking, for the purpose of enhancing the keeping quality of the butter.

W.H.M.

93. More Money with Malted Milks. Ice Cream Trade J., *34:* 12, 14, 1938.

Four fundamentals to be observed in making good malted milks are fresh, pure ingredients, used in sufficient quantities, milk that is very cold and sufficient mixing. A recognized formula for a malted milk is: 1½ oz. syrup, 2 #20 scoops ice cream, 6 oz. cold milk, and ½ oz. malted milk powder. Companion items that can be sold with malted milks are toasted raisin cake, small peanut butter sandwiches, various desserts, cinnamon toast, regular sandwiches, and various other special items. Mocha, coffee, planter's special, banana, and chocolate mint are some variations which may be used. Dealers will usually cooperate in merchandising 20 cent malted milks, and the customer will pay the price provided the malt is made of high quality ingredients.

W.H.M.

94. Suggestions for Sanitation of Ice Cream and Ice Cream Plants. J. H. FRANDSEN, Head, Dep't of Dairy Industry, Mass. State College, Amherst, Mass. Jour. of Milk Tech., *1:* 2, 14–17, 1938.

Besides the ingredients as sources of high bacterial counts in ice cream, the equipment used may be a factor, and also the human equation.

L.H.B.

95. Standardization of Rulings on Equipment and Supplies. HARRY S. CALVERT, President Dairy and Ice Cream Machinery and Supplies Ass'n, New York City. Jour. of Milk Tech., *1:* 2, 10–13, 1938.

This is an appeal to unify or standardize the rulings and regulations concerning equipment so that they would be acceptable to all authorities. This could be done by joint meetings of committees appointed from both the Milk Sanitarians and the Dairy and Ice Cream Machinery and Supplies Association.

L.H.B.

96. Maintaining Ice Cream Quality in California. F. W. MILNER, Calif. Dept. of Agriculture, Sacramento, Calif. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *2:* 60, 1938.

Although laws and regulations are primarily for the consumer's protection, it has been found that the industry itself recognizes and appreciates the value of reasonable standards. Enforcement agencies should realize that proper enforcement requires patience and good sound judgment.

In a discussion of factory sanitary requirements, and ice cream standards for food solids and bacterial content, the author presents excerpts from the California Sanitary Code for the manufacture of ice cream. The need for revision of sanitary regulations each year is set forth. The results from the enforcement of the state regulations in California is shown graphically by a comparison of bacteria counts for 1928, 1930, 1937, and 1938. In 1938 62 per cent of the ice creams tested contained less than 10,000 bacteria per cc. and only 6.5 per cent exceeded 100,000 bacteria per cc. In 1928 results for the like groupings were 18 and 70 per cent, respectively.

In California the inspection service has attempted to help those manufacturers without sufficient volume to justify the expense of proper laboratory control. A considerable amount of educational and service work has been done, especially with such groups which are unable to help themselves. Results indicate that the improvement in quality of ice cream demonstrates the value of this cooperative program. M.J.M.

97. Maintaining Ice Cream Quality in New York City. S. ABRAHAM, Division of Milk Inspection, Department of Health, New York, N. Y. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *2:* 55, 1938.

A more serious attempt to control the sanitary quality of ice cream began in 1933 with the passage of a revised set of regulations copied after those already in use for market milk. The routine control of the wholesale manufacturing establishments of ice cream consists of physical inspection of the plants and the supervision of methods of processing and handling. Equipment and containers are inspected for sanitary construction, cleanliness, and sterility and the products are sampled for chemical and bacteriological quality. Equipment must be completely dismantled after each day's run and properly sterilized both before and after use.

The bacteria counts obtained for the first 9 months of 1938 showed that 59.7 per cent of the samples of ice cream contained less than 5,000 bacteria per cc. while 9.5 per cent were in excess of the permitted maximum of 100,000 per cc.

Recognizing that the inspection personnel cannot alone insure a product of high sanitary quality, an attempt has been made to reach ice cream manu-

facturers and their employees as well as equipment manufacturers. Before the 1938 ice cream season reached peak production, a series of lectures were given to the ice cream manufacturers and their key employees on the subject of, "The Production of Quality Ice Cream." It was generally conceded that "quality consciousness" was created through this course. M.J.M.

98. Cold Storage Lockers. Anonymous. Ice Cream Rev., *22:* 5, 54, 1938.

The possibilities and problems involved in establishing cold storage lockers in connection with an ice cream business is discussed. The view is expressed that these establishments are destined to be an important and permanent factor in the frozen foods industry. Refrigerated lockers are rented to consumers at from $10 to $15 per year for the storage of perishable foods.
J.H.E.

99. Frosted Foods in the Retail Ice Cream Store. JOHN HUMPHRIES, Dayton, Ohio. Ice Cream Rev., *22:* 5, 52, 1938.

The experience of a chain of retail ice cream stores in handling frozen foods is given. The sales were made up of approximately 37 per cent fruits, 34 per cent vegetables, 23 per cent seafoods and 6 per cent poultry.
J.H.E.

100. Sanitation at the Soda Fountain. Anonymous. Ice Cream Rev., *22:* 5, 28, 1938.

The dangers of unclean glassware or silverware at the fountain are emphasized. Paper service is recommended as more sanitary and enables the store operator to handle the crowds with less confusion during rush periods.
J.H.E.

101. Increasing Sales of Bulk Ice Cream. Anonymous. Ice Cream Rev., *22:* 5, 22, 1938.

102. Control of B. coli in the Manufacture of Ice Cream. CHARLES PALEY, Certified Laboratories Inc., New York City. Ice Cream Rev., *22:* 4, 33, 1938.

A summary is given of the common causes for contamination of ice cream with *B. coli.* In eliminating *B. coli* greatest stress should be placed on the sterilization of the equipment coming in contact with the pasteurized product and on the quality of the ingredients added after pasteurization. J.H.E.

103. The Consumer Movement—and How to Meet It. L. O. BROWN, Assoc. Prof. of Marketing and Advertising, Northwestern University, Chicago, Ill. Ice Cream Rev., *22:* 4, 34, 1938.

The consumer movement can be an asset to business. It is essential that market research and market analysis be made in order to know what the consumer thinks. It is also important to give the consumer a better knowledge of products and services.

The results of a survey attempting to find out what the housewife thinks about ice cream are given in this article. Amongst a typical group, 49.5 per cent believed that commercial ice cream contains cornstarch as a filler. Forty-four per cent believed that packaged ice cream contains a filler not present in bulk ice cream. Fifty per cent of the women believed ice cream tends to make people fat. Other results are given. J.H.E.

104. Dipper Sinks with Running Water for Ice Cream Service. C. A. ABELE, Director Div. of Inspection, Ala. State Health Dept. Ice Cream Rev., *22:* 3, 74, 1938.

A study of 40 samples of water in which ice cream dippers were immersed revealed that the bacterial content of the water ranged from 600 per cc. to 20,000,000 per cc. The average count of the water from five receptacles into which a small stream of water was constantly flowing was 9,500 per cc., the extremes being 600 and 77,000 per cc. J.H.E.

105. Special Flavors. Anonymous. Ice Cream Rev., *22:* 3, 49, 1938.

During the cold months of the year when consumption of ice cream depends on taste appeal, the frequent introduction of new flavors is worth a great deal in maintaining volume. Items such as Hawaiian Fruit Salad, Pistachio nut, Banana nut and Marshmallow nut are suggested as distinctive flavors for winter sales. J.H.E.

106. Some Sanitary Problems of the Ice Cream Industry. ROBERT C. HIBBEN, Exec. Sec. of Int. Assn. of Ice Cream Mfrs., Washington, D. C. Jour. Milk Tech., *1:* 3, 43–48, 1938.

The chief sanitary problem of the ice cream industry is the lack of uniformity in regulations imposed upon the industry in the different states, counties and cities by the various health departments.

Instances are cited of duplication in inspection when products are bought or sold in different cities, counties, or states, the cost of which must be borne by the industry.

Simple regulations adequately enforced are better than complicated regulations with no enforcement.

There should be equal enforcement of regulations for all plants regardless of size. L.H.B.

107. Ice Cream Sales Index. Special Bulletin of the Int. Assn. of Ice Cream Mfrs., 1105 Barr Bldg., Washington, D. C., Nov. 1938.

An analysis is given of ice cream sales for the United States and Canada for the first 8 months of 1938. Sales in the United States decreased for the 8 month period, 4.98 per cent when compared with the like period in 1937; in Canada the loss in sales for the same period was 4.66 per cent.

The bulletin also contains the percentage of the total amount of milk produced each month and the monthly production of ice cream. The contribution of the ice cream industry towards meeting the surplus milk problem is thus graphically shown. The "ice cream expense dollar" is also analyzed with a break-down showing the natural costs by percentage as well as functional costs. M.J.M.

108. Outline of Activities for the Year 1938. ROBERT C. HIBBEN, Special Bulletin of the Int. Assn. of Ice Cream Mfrs., Washington, D. C., October, 1938.

This bulletin contains a summary of the activities for the year 1938 of the International Association of Ice Cream Manufacturers as well as that of the affiliated organization, the Ice Cream Merchandising Institute, Inc.

M.J.M.

109. Report of Simplified Practice Committee. RIDGWAY KENNEDY, JR. Abbotts' Dairies, Inc., Philadelphia, Pa. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *1:* 59, 1938.

In 1933 the committee submitted dimensions for an ice tray package to fit in the freezing unit of the mechanical refrigerator. This package is now widely used by the industry.

In order to further the use of the mechanical refrigerator for storing commercial ice cream, refrigerator manufacturers have been urged to provide a height of at least 4 inches in at least one of the ice tray compartments in order to accommodate the various types of ice cream containers. At least two manufacturers report that suitable space has been provided for this purpose and it is believed that others will also allow sufficient head room in these compartments for the storage of packed ice cream. M.J.M.

110. Management's Responsibility for Sound Industrial Relationships. HAROLD B. BERGEN, McKinsey, Wellington & Co., New York, N. Y. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *1:* 38, 1938.

The author summarizes as follows the steps he believes the International Association of Ice Cream Manufacturers should take in order to facilitate sound industrial relations.

1. Appoint an industrial relations committee to study labor problems and formulate recommendations to your members.
2. Study and interpret all labor legislation affecting your industry.

3. Make a survey of existing wages and hours in the various job classifications in your industry; include information on overtime practices, vacations with pay, holidays, and time off for personal matters.

4. Collect information on current practices regarding retirement plans, death and disability benefits, and unemployment benefits and dismissal and compensation.

5. Collect information on current practices regarding employment procedures, training methods, health and safety procedures, and the like.

6. Develop material to be used in connection with the training and education of employees.

7. Collect information about the progress of unionization in your industry, collective bargaining, and labor disputes (if any).

8. Develop an industrial relations code or statement of personnel policies to be recommended to the membership.

9. Prepare informational material on the industrial relations practices of your industry to be disseminated to the public.

10. Be prepared to bargain collectively for your members on a community-wide basis.

The development of the program suggested should not prove costly. It should pay definitely in terms of dollars and cents, although it may be difficult to isolate its effects in terms of increased sales or decreased operating costs. Also, several years are likely to elapse before its full benefits are realized. But unquestionably, a sound, long-range industrial relations program will prove a profitable investment. M.J.M.

MILK

111. Use of the Lactometer. L. M. LAMPERT, Dairy Service Laboratory, Dept. of Agr., Sacramento, Calif. Milk Dealer, *28:* 3, 25, 50, 1938.

The differences in specific gravity readings made on milk by different laboratories are due to the fact that there is no standard procedure for using the lactometer. It is pointed out that the United States Bureau of Standard calibrates lactometers to be read at the top of the meniscus when floating in milk, that they have been calibrating lactometers in this manner for more than 23 years, and that the principal manufacturers of lactometers in the United States calibrate their instruments to be read to the top of the meniscus. The author summarizes his discussion as follows:

1. The lactometer reading should be made at the top of the meniscus.

2. Calibration of the lactometer may be made in milk of known specific gravity.

3. Unless the prior treatment of a sample of milk is known, an element of uncertainty is present in values of solids-not-fat derived by formula from the specific gravity.

4. With samples having their maximum specific gravity, the average of results obtained by the Babcock formula from the lactometer readings and the percentage of fat agree fairly well with the average gravimetric results.

5. With samples in which the original specific gravity has been restored by heating the average of results obtained by the formula $SNF = \frac{1}{4} + \frac{1}{5} F + 0.2$ agree well with the average gravimetric results.

6. Values on individual samples obtained by formula may vary considerably from values obtained gravimetrically. C.J.B.

112. **Raw or Pasteurized Milk.** Anonymous. Am. Jour. Pub. Health *28:* 12, 1424, 1938.

This is a discussion of a report by a Milk Nutrition Committee in England in which 8,435 children were divided into four groups. The children were fed a diet to which milk was compared with biscuit, also as a supplementary diet, and were studied as to increase in height and weight after having been assessed clinically as to their general condition. The general results were in favor of milk as a supplement. No consistent difference was apparent in the increments between children whose supplement was $\frac{2}{3}$ pint of pasteurized milk and the children whose supplement was $\frac{2}{3}$ pint of raw milk. M.W.Y.

113. **Practical Experience with the Scharer Rapid Field Test for Pasteurization.** D. M. Roger, Borden's Farm Products, New York, N. Y. Am. Jour. Pub. Health *28:* 11, 1325, 1938.

The author discusses a year's experience with the test in plant control in which over 18,000 tests were performed. Causes of false and erratic tests are discussed. The method is simple and the author concludes that when performed with care, its accuracy closely approaches that of the longer laboratory tests. A 30 minute incubation period aided in the detection of slightly under-pasteurized samples. M.W.Y.

114. **A Critical Discussion of Some Methods and Standards for Certified Milk.** J. Howard Brown, Dept. of Pathology and Bacteriology, Johns Hopkins Univ., Baltimore, Md. Am. Jour. Pub. Health, *28:* 9, 1053, 1938.

The author discusses: (1) certain features of medical milk commission control, (2) the bacteriological methods and standards for certified milk, and (3) pasteurization of certified milk. With a knowledge of the required bacterial count, the compliance rating, and the uniformity rating, one obtains more nearly complete information of the bacteriological quality of the milk than is revealed by either the arithmetical or the logarithmic average. Reasons are presented for the requirement by Methods and

Standards that when certified milk is pasteurized, it shall be pasteurized and bottled on the farm where it is produced and that the pasteurizing equipment shall not be used for the pasteurization of any other grade of milk. M.W.Y.

115. Ropy Milk—Its Causes and Prevention. J. H. FRANDSEN and MEYER GLICKSTEIN, Mass. State College, Amherst, Mass. Extension Leaflet 181, December, 1938.

The authors describe different causes for outbreaks of ropy milk in milk plants and on farms. A method for detection of milk that has a tendency to develop ropiness is given. Remedial measures to stop a ropy milk outbreak and rules to follow to prevent ropiness are listed. H.G.L.

116. Certain Practical Aspects of the Use of Paper Milk Containers. P. H. TRACY, Dept. of Dairy Husbandry, Univ. of Ill., Urbana, Ill. Jour. Milk Tech., *1:* 3, 40–42, 1938.

This report deals with the Pure-Pak container, formed and paraffined immediately before being filled.

Some of the points studied and reported are:

A case of 12 quarts of milk in paper bottles weighs approximately 28 pounds.

It requires 12–15 grams of paraffin to coat the containers. Paraffin did not chip off of the containers into the milk.

The amount of moisture absorbed by the walls of quart containers varied from 0.5 to 2.5 grams.

Bulging of side walls was a minor problem. There was but slight difference in the rate of temperature change of milk in paper and glass containers. Milk warmed slower in paper. Effect of sunshine on milk in paper containers was not nearly as serious as in glass bottles. Consumer preference for the paper container was shown by 221 questionnaires returned by customers on the University milk route. L.H.B.

117. Report of Committee on Dairy Farm Methods. F. D. HOLFORD, Chairman. Jour. Milk Tech., *1:* 3, 30–33, 1938.

This report deals with three topics, the sediment in milk, mastitis in dairy cows, and sterilization of dairy utensils on the farm.

Sediment. Methods of taking sediment tests are discussed, as are sources and methods of preventing sediment. Proper methods at the source of production will reduce sediment to a minimum.

Mastitis. The effect of mastitis on the properties of milk is shown in a table. The committee suggests that the following problems should be solved.

1. How much public health significance has mastitis?

2. Has the hemolytic streptococcus (epidemicus type) in raw milk before pasteurization as much significance as typhoid organisms, tubercular organisms and other pathogens?

3. Should all cases of mastitis be considered a potential danger until the specific organisms causing the infection have been differentiated?

4. Does the abnormal milk produced by mastitis cows and included in a pasteurized supply affect its quality?

5. Should prevention be considered our first line of defense in the production of safe milk?

6. Should pasteurization be accepted as our second line of defense?

7. Is it safe to place all our confidence in the pasteurizing process?

8. Due to the magnitude of the problem, are the dairy industry and public health officials reluctant to acknowledge its importance?

Sterilization of Utensils on the Farm. Milk utensils should be cleaned at the point where the water is heated.

It is very essential to have clean surfaces where chlorine is used.

In sterilizing milking machines it is more efficient to have the chlorine solution constantly dripping through the tubes than just placing the tubes in the solution.

Some means for testing the strength of the solution should be available. Starch iodine papers have been successfully used. L.H.B.

118. The Use of Social Security Funds in Training Milk Inspectors. C. E. WALLER, Asst. Surgeon General, U. S. Public Health Service, Washington, D. C. Jour. Milk Tech., *1:* 3, 16–21, 1938.

Social security funds are available to state health departments. The state health officer may devote to milk sanitation and to training personnel for this work any part of his allotment which he may consider proper in relation to other activities. L.H.B.

119. Observations on Problems Relating to the Paper Milk Bottle. E. WHEATON, R. H. LUECK, and F. W. TANNER, Bacteriological Laboratories of the American Can Company, Maywood, Illinois, and the Univ. of Ill., Urbana, Ill. Jour. of Milk Tech., *1:* 3, 11–15, 1938.

The results reported in this paper are of a study made on only one type of bottle, but the authors believe their conclusions will apply to other similar type bottles. The conclusions are based on results obtained from more than four years of investigation on thousands of bottles.

Conclusions reached are as follows:

Approximately 80 per cent of all fibre milk containers are sterile. Of the remaining 20 per cent more than 90 per cent showed fewer than five

organisms per bottle. Escherichia coli have been consistently absent. Bacterial types found on the plates have been white staphylococci, yellow sarcina, spore forming and non-spore forming rods. Rarely have molds been isolated.

Their data indicates the best method for making tests is to rinse the bottles with 10 ml. of sterile water and then plate the entire recoverable portion.

L.H.B.

120. **Report of Committee on Methods of Improving Milk Supplies in Small Communities.** LESLIE C. FRANK, Chairman. Jour. of Milk Tech., *1:* 3, 27–29, 1938.

Only 20 per cent of the municipalities in the 1,000 to 10,000 population group have some form of milk control.

Only 38.6 per cent of the milk sold in communities of 1,000 to 10,000 population group is pasteurized. The average state milk control staffs are too small to cope with the milk problem in all the small communities in the state. To do this adequately would require a four- or five-fold increase in the present state staffs.

From a study made by the U. S. Public Health Service it is reported that 66 per cent of all milk-borne epidemics reported during the decade from 1927–1936 occurred in communities of 10,000 population or less.

Reasons for lack of inspection in small communities are given as well as some points which the committee believe should be stressed to remedy the situation.

L.H.B.

121. **Plumbing Hazards in Pasteurization Plants.** W. SCOTT JOHNSON, Chief Public Health Engineer, State Board of Health of Missouri, Jefferson City, Mo. Jour. of Milk Tech., *1:* 3, 3–10, 1938.

A recent survey of the plumbing and piping systems of six large milk plants indicated the need for checking these items.

A total of 210 defects were found in these plants, ranging from 14 defects found in one plant to 61 in another. Most common defect found was type 2 with 135 and type 6 with 43.

The defects were classified into six types as follows:

Type 1. Direct pipe or equipment connection between potable water supply and sewage or other contaminated water, with or without check or manual valve between, which through excessive back pressure or negative head, or both, might result in the contamination of the potable supply with sewage or polluted water. Example—Polluted water pump directly connected to potable water supply; condensers directly connected to potable water supply and also to sewer lines; drains or overflow from potable water tanks directly connected to sewer lines; mechanical refrigerating units directly connected to potable water supply and sewer lines.

Type 2. Potable water supply inlets submerged constantly or because of direct or indirect stoppage that, due to a negative head or vacuum in the potable water supply lines, might result in the contamination of the potable water supply with sewage or polluted water through back siphonage. Example—Constantly submerged inlets which are hazardous even when the fixtures are in good operating condition such as siphon jets in water closets and urinal traps, laundry washing machines, processing tanks, water softeners, and stockwater basins. Inlets not ordinarily submerged beneath the surface of the fixture contents but which at times become submerged due to carelessness in filling or to stoppage of outlets, such as flushing rim openings in water closets, urinals, and slop sinks, lavatories, aspirators, utility room sinks, drinking fountains, bottle washers, loose hose, etc.

Type 3. Sewer lines located over pasteurizers or other milk processing equipment; floor drains located in refrigerators or other rooms where food is stored or processed and in rooms where ice is made or prepared for use.

Type 4. Water supply subject to aerial pollution. Example—Potable water supply tanks with open or loose tops or covers located on roof of building or other exposed location.

Type 5. Possible infection of persons through use. Example—Incorrectly designed drinking fountains which can be contaminated by user with possible hazard to subsequent users.

Type 6. Equipment designed to hold food during processing, surrounded by or containing pipes or jacket through which the water supply is circulated. Frequently this type of equipment is rinsed with tap water just previous to use. The danger from such connections and operation is predicted upon the water supply becoming contaminated due to other faulty plumbing and the development of breaks in the pipes or jacket so that contaminated water would leak into the food supply. Example—Certain types of milk pasteurizers, milk holding vats, milk coolers, and other equipment in which dairy products are heated or cooled or both.

Illustrations of defects and means for correcting them are given.

L.H.B.

122. Steam vs. Hot Water as a Heating Medium for Pasteurizing Milk. R. C. STRACHAN, Dairy Engineer, Pfaudler Co. Milk Dealer, *28:* 2, 52–54, 1938.

R. C. Strachan, Dairy Engineer with the Pfaudler Co., points out that steam heating of glass-lined vats is actually water or vapor heating. When steam enters the jacket under pressure, it expands. As it contacts the heating surface, a condensate is formed. This evidences itself as a thin film of water running down the heating surface. It is further shown that agitation is an important factor in pasteurizing milk. That the rate of circulation must be in direct relation to the temperature of the heating medium—

the higher the temperature, the faster the circulation. The latter statement is substantiated by tests at Ohio State University and at the New York State Experimental Station. The tests at Ohio State University indicated that steam may be used as a heating medium with no detrimental results providing agitation is sufficiently great to provide rapid transfer of the heat. The following conclusions were reported at the New York station:

1. Milk was pasteurized in a glass-lined vat without imparting a cooked flavor with heating water as high as 210° F. or steam at 220° F. under pressure.

2. The temperature of the heating medium did not affect the creaming properties of the milk.

3. Momentary heating of milk to a temperature of 170° F. for one minute did not produce a cooked flavor.

4. These studies indicated that milk will withstand much more severe temperatures without developing cooked flavors than is generally supposed. Cooked flavors tend to leave milk during aging and the cardboard flavor which often develops is sometimes mistaken for the cooked flavor. C.J.B.

123. Proposed Standards for Paper Milk Containers. J. R. SANBORN, New York Agr. Exp. Sta., Geneva, N. Y. Jour. of Milk Tech., *1:* 2, 41–45, 1938.

Strict sanitary methods of manufacturing, handling, conveying and storing the paper board are important. The bacteriological content of the original container board was found to be a factor in the bacterial counts of the finished container.

Certain principles of sanitation which should be observed in the manufacture and use of paper containers are given.

It is suggested that the bacteriological standard for paper containers be the same as those suggested by the American Public Health Association for glass bottles.

The regulation pertaining to paper containers adopted by the Baltimore City Health Department is considered to be deserving of further study. Suggestions are given for amending some of the items. L.H.B.

124. Milk Plant Equipment of the Future. C. SIDNEY LEETE, Asso. Milk Sanitarian, New York State Dept. of Health, Albany, N. Y. Jour. of Milk Tech., *1:* 2, 38–40, 1938.

The use of the phosphatase test has revealed the need of certain features in our milk plant equipment. Some of these are:

1. Automatic, rather than manual control of pasteurizers.
2. Agitation of milk during holding period.
3. Air space or foam heaters.

4. A perforating device for recording thermometer charts to prevent operators pushing charts.

Some other devices needed are constant capacity pumps for continuous flow pasteurizers, improvement in can and bottle washing machinery to insure properly sterilized containers, and the use of seamless milk cans in place of soldered cans. L.H.B.

125. Discussion of the Use of the Phosphatase Test. PAUL F. KRUEGER, Director, Bureau of Dairy Products, Chicago Board of Health, Chicago, Ill. Jour. of Milk Tech., *1:* 2, 36–37, 1938.

"After intensive study it was found that the test could be relied upon to give an accurate report of the conditions surrounding the pasteurizing process."

The test brought to light many samples of improperly pasteurized milk. With the intensive use of the test, however, the number of improperly pasteurized samples are becoming rare.

Some of the causes for improper pasteurization found by the use of this test are discussed. L.H.B.

126. The Phosphatase Test. ARNOLD B. STORRS and L. H. BURGWALD, Dept. of Dairy Tech., Ohio State Univ., Columbus, Ohio. Jour. of Milk Tech., *1:* 2, 18–35, 1938.

Gives detailed instructions for making the Kay and Graham test; also instructions for preparing the phenol standards used by Gilcrease and Davis as well as instructions for Scharer's modified tests.

In a series of tests made by the Kay and Graham method on milk pasteurized in the laboratory it was found that in using the standard of 2.3 Lovibond blue units recommended by Kay & Graham for properly pasteurized milk, that a 24-hour incubation period was satisfactory for milk pasteurized at 143° F. for 30 minutes, but if the regulation permitted milk to be pasteurized at 142° F. for 30 minutes, then a 5-hour incubation period should be used.

The test could also be applied to the high temperature short time holding systems, and a 24-hour incubation period was found to be satisfactory when milk was held at 160° F. for more than 15 seconds.

There was no relation between butterfat content of mixed herd milk, and the phosphatase content. Neither was there any relationship between the phosphatase content of the raw milk and the blue color developed in the same milk after pasteurizing.

The modifications suggested by Scharer gave promise of having considerable merit. L.H.B.

127. Sanitary Aspects of Paper Milk Containers. M. J. PRUCHA, Univ. of Ill., Urbana, Ill. Jour. of Milk Tech., *1:* 2, 4–9, 1938.

This paper is a progress report on some sanitary problems connected with the use of paper containers for fluid milk.

It gives a description of the manufacturing process.

Bacteriological examination made during the process showed that the pulp was contaminated at various stages when washed with water. It was suggested that the paper mills be inspected by milk sanitarians and the purity of the water supply checked. Health certificates should be required of all persons handling the paper in the mill, in the carton manufacturing plant and in the milk plant.

Containers that are paraffined in a factory and shipped ready to be filled must be protected from insects and dust at all times. Paraffining containers at 185° F. for 30 seconds resulted in a practically sterile container.

L.H B.

128. Phosphatase Test for Gauging the Efficiency of Mix Pasteurization. HARRY SCHARER, Department of Health, New York, N. Y. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *2:* 50, 1938.

Modifications of the published method for the phosphatase test are given. The modifications are necessary for successful application of the test to ice cream.

At first thought it would seem that, with the use of relatively high temperatures for mix pasteurization, the phosphatase test would be of little use. However, this is not necessarily the case. The lack of effective pasteurization occurs, often due to the total or partial omission of the holding period or to contamination with raw products by standardization.

Interfering substances must be taken into consideration, such as vanilla powder, vanillin or coumarin, some chocolate or cocoas and some color solutions. Cooked fruit products and synthetic fruit flavorings may introduce phenolic substances. Lemon flavoring introduced a phenol while lemon juice introduced the phosphatase enzyme. One brand of cold-packed strawberries introduced both phenol and enzyme. Unroasted nut meats may also introduce the enzyme.

These interferences and the subsequent color reactions emphasize the need for careful interpretation of results and the necessity for control tests on the various ingredients.

M.J.M.

MISCELLANEOUS

129. 10 Ways to Reduce Truck Maintenance. Anonymous. Milk Dealer, *28:* 3, 26, 38, 1938.

Reducing truck maintenance is discussed under the following headings: 1. Standardization, 2. Regular inspection, 3. Frequent tune-up, 4. Adjust trucks to job at hand, 5. Better gasoline mileage, 6. Centralize purchases,

7. Good tires and retreading, 8. Extra braces, 9. Washing and greasing, 10. Frequent painting. C.J.B.

130. **What's New in Farm Science.** Part 1. 55th Annual Report for year ended June 30th, 1938. Agri. Exp. Sta., Univ. of Wis., Madison, Wis. C. L. Christensen, Director. Compiled by Noble W. Clark, Associate Director, and Niemen Hoveland. Bulletin 442, November, 1938.

This bulletin briefly summarizes findings of work newly completed or in progress. The following sections are of interest to the dairy industry:

Fluid milk distribution costs. W. P. Mortenson, Lawrence Witt, and Carl Heisig. This report analyzes the records of thirteen Wisconsin dairy companies for the past six to ten years.

Large dairy plants handle nearly half Wisconsin's milk. p. 7. A. W. Colebank, and R. K. Froker, Univ. of Wisconsin, and A. C. Hoffman, U.S.D.A. Of 2,882 dairy plants operated in Wisconsin in 1935, 246 handled 48 per cent of all milk produced in the state.

Consumers buy more cheese during and after sales campaign. p. 8. Asher Hobson and Marvin A. Schaars.

Inflexibility of retail prices may discourage use of cheese. p. 12. Don Anderson. Retail prices of cheese have not consistently followed the trend of factory prices during the past twenty-five years.

Cold storage locker plants. p. 24. Marvin A. Schaars.

How accurate is the Bang's test? p. 54. B. A. Beach. In four different herds six cows were found which were carriers of the Bang's organism even though they never had reacted to the blood test. Bang's test has worked so well in such a huge majority of dairy herds that its advantages far outweigh its limitations.

Seeks new products from micro-organism. p. 61. W. R. Peterson, E. B. Fred, E. McCoy, *et al.* These studies discuss lactic acid bacteria, butyric acid anaerobes, fermentation of wood sugar liquor, products of proprionic acid bacteria, industrial production of lactic acid, enzymes of micro-organisms, physiology of anaerobic bacteria, antidermatitis factor in yeast.

Make further tests on tuberculins. p. 64. J. R. McCarter and E. G. Hastings.

Trials show allowable variations in handling Swiss cheese cultures. p. 67. H. J. Peppler, P. R. Elliker and W. C. Frazier.

Bacteriology of Brick cheese. p. 68. J. C. Garey, C. C. Schmiege, and W. C. Frazier.

Brick cheese factories need better control of starters. p. 69. W. L. Langhus, P. R. Elliker, and W. V. Price.

Splitting of Brick cheese. p. 70. F. E. Hanson, D. W. Spicer and W. V. Price.

Acidity of Brick cheese. p. 72. D. W. Spicer and W. V. Price.

Measuring salt in butter. p. 73. K. G. Weckel.

Physical properties of butter. p. 73. K. G. Weckel.

Activated flavor in milk. p. 74. J. C. Flake, K. G. Weckel, and H. C. Jackson.

Rancid flavor in dairy products. p. 75. J. C. Pfeffer, K. G. Weckel, and H. C. Jackson.

Oxidized flavor in milk traced to fat-related substances. p. 75. A. M. Swanson and H. H. Sommer.

Research improves milk irradiation methods. p. 76. H. H. Sommer, H. C. Jackson, and K. G. Weckel.

Studies on legume silage. p. 88. W. H. Peterson, C. A. Elvehjem, E. B. Hart, H. Steenbock, *et al.*

Grass juice factor. p. 91. G. O. Kohler, S. B. Randle, C. A. Elvehjem, and E. B. Hart.

Some factors affecting utilization of vitamin A. p. 92. E. J. Lease, J. G. Lease, J. H. Weber, and H. Steenbock. W.V.P.

131. What We Imagine We Know about Butter Workmanship. L. C. THOMSEN, Univ. of Wis., Madison, Wis. Nat. Butter and Cheese Jour. *29:* 23, 12, 1938.

Rules for working butter are reviewed because proper butter workmanship is more important now than it was eighteen years ago. Investigations on the influence of feed, chemical composition of butterfat, manufacturing operations, and physical state of fat in butter are reviewed briefly. W.V.P.

132. Report of Committee on Dairy and Milk Plant Equipment. WALTER D. TIEDEMAN, Chairman. Jour. Milk Tech., *1:* 3, 34–36, 1938.

One of the important items mentioned in this report deals with milk bottle caps that cover the pouring lip.

The committee directs special attention to the need of further improvement in equipment designed for pasteurizing and handling the milk after pasteurization. L.H.B.

133. Some Highway Problems of the Dairy Industry. CHESTER GRAY, National Highway Users Conference, Washington, D. C. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *1:* 66, 1938.

The dairy industry is a heavy user of national highways. It has at least 1,270 fleets of trucks containing eight or more units carrying milk, dairy products, butter, and eggs. This figure does not begin to account for the total number of trucks employed by the industry, especially since so many trucks used for hauling milk are farmer owned.

For New York, Boston, and Philadelphia, more than 49 per cent of the milk and at least 24 per cent of the cream consumed arrives by trucks. Milk received by truck in New York City increased by 6.4 per cent in two years. There is a definite trend towards the motor vehicle for transporting dairy products.

The dairy industry should actively sponsor better highway planning and carefully follow interstate commerce laws as they affect the trucking industry. There is also a need for more uniformity in sizes and weights of motor vehicles. The writer urges a careful consideration of the fundamentals of highway transportation by the dairy industry. M.J.M.

134. Practical Suggestions for Changes in the Social Security Act. T. J. MAHONEY, The Borden Co., New York, N. Y. Proc. 38th Ann. Conv. Int. Assn. of Ice Cream Mfrs., *1:* 49, 1938.

Suggestions are made for changing state regulations drawn up under the Social Security Act. These recommendations, including the "merit rating system" for unemployment compensation, it is believed, will help both the employer and employee. M.J.M.

135. Boilers for Dairies—Their Care and Selection. Milk Dealer, *28:* 2, 38–39, 62–68, 1938.

A discussion of the advantages, disadvantages, and care of the four types of boilers most frequently used in the dairy industry. C.J.B.

PHYSIOLOGY

136. Maintenance of Pregnancy by Progesterone in Rabbits Castrated on the 11th Day. WILLARD M. ALLEN and GEORGE P. HECKEL, Department of Obstetrics and Gynecology, School of Medicine and Dentistry, Univ. of Rochester. Amer. J. Physiol. *125:* 1, 31, 1939.

Pregnancy can be maintained to term in rabbits castrated on the 11th day after mating providing 2.0 mgm. of progesterone are given daily from the 11th to 15th days inclusive and 4.0 mgm. daily from the 16th to 28th days inclusive. It is apparent that the late pregnancy changes are brought about by the combined action of progesterone (produced either in part or entirely by the ovaries) and some other hormone, probably an estrogen elaborated by the placenta. The ovary need contribute nothing other than progesterone. D.L.E.

137. Ease of Body Heat Loss as a Basic Developmental and Functional Factor in Warm-blooded Animals. C. A. MILLS and CORDELIA OGLE, Laboratory of Experimental Medicine, Univ. of Cincinnati. Amer. J. Physiol. *125:* 1, 36, 1939.

The body is only about 20 per cent efficient in the performance of muscular work. The remaining 80 per cent must be dissipated, since the body is very sensitive to the accumulation of waste heat. Such basic metabolic factors as growth, rate of development, and fertility are shown to be dependent on the ease with which body heat can be dissipated. No matter what the air temperature level, if the radiant heat load falling on the skin is so great as to make difficult the dissipation of this heat and that internally produced, then the body's response will be a reduction in internal combustion and a slowing down of its metabolism. The avenue of heat loss seems unimportant. Adequate loss by radiation alone provides just as effective body stimulation as does a similar net rate of loss through the usual combined avenues of conduction, convection and radiation.

It would seem advisable that standards of environmental conditions be established for laboratory animals so that results obtained in different climates and seasons can justly be compared. D.L.E.

138. The Influence of Hydrogenation and Oxidation of Fats upon Their Rate of Absorption. MARGARET HOUSE IRWIN, JANET WEBER, H. STEENBOCK and T. M. GODFREY, Dept. of Biochemistry, Univ. of Wis., Madison, Wis., and Lever Brothers Company, Cambridge, Mass. Amer. J. Physiol. *124:* 3, 800, 1938.

With rats the rate of absorption of fat was found to decrease as the melting point increased above body temperature. Variations in melting point below body temperature had no effect upon the rate of absorption.

The rate of absorption of hydrogenated cottonseed oil was found to vary inversely (from 58 to 37 per cent in four hours) with the degree of oxidation (peroxide number, 0.5 to 127.7). D.L.E.

139. Rôle of Progesterone and Other Hormones in Survival of Pseudopregnant Adrenalectomized Ferrets. ROBERT GAUNT and H. W. HAYES, Departments of Biology, Washington Square College, New York University, New York City, and Princeton University, Princeton, N. J. Amer. J. Physiol. *124:* 3, 767, 1938.

Symptoms of adrenal insufficiency can be prevented in adrenalectomized ferrets by injection of crystalline progesterone or by inducing pseudopregnancy. The absence of adrenal insufficiency during pseudopregnancy is probably due to the secretion of progesterone. This indicates that the function of progesterone may be more generalized than its action on the reproductive tract alone.

No adequate explanation is available for the adverse effects of estrus and the estrogens after adrenalectomy but the suggestions that they inhibit the pituitary has not been substantiated. D.L.E.